

LATE TERTIARY AND EARLY QUATERNARY FOSSIL MOLLUSCA
OF THE HONDEKLIP AREA, CAPE PROVINCE, SOUTH AFRICA

By

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(With 42 figures and 1 table)

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ABSTRACT

A brief review of the Quaternary mollusc research of the west coast of South Africa is provided. Molluscan fossils were obtained from two coastal regressive sedimentary complexes. The older complex records a regression from c. +50 m, and is called the 50 m Complex. Stratigraphic context in terms of global sea-level curves and the presence of *Equus* in this complex suggests a Late Pliocene age. The subsequent complex records a regression from c. +30 m, is called the 30 m Complex, and is considered Early Pleistocene in age.

The following 21 species and one subspecies are described as new: *Patella hendeyi*, *Patella hoffmani*, *Clanculus lutosus*, *Gibbula zonata patula*, *Bolma anoropha*, *Crepidula deprima*, *Argobuccinum casus*, *Epitonium lycocephalum*, *Thais arenae*, *Ocenebra petrocyon*, *Trophon carringtoni*, *Burnupena rogersi*, *Burnupena aestus*, *Fasciolaria dinglei*, *Melapium hawthornei*, *Pseudoliva lutulenta*, *Drillia tempestae*, *Terebra canisaxi*, *Glycymeris fulleri*, *Isognomon gariesensis*, *Cardita unica*, *Dosinia sicarisinus*. A number of previously described mollusc species are discussed or redescribed. The faunal composition and biogeography of the Hondeklip assemblage are discussed, and the assemblage is compared with other west-coast fossil assemblages. Temperature tolerances of some extant forms present indicate that a warmer water regime relative to modern conditions existed along the Namaqualand coast during the Late Pliocene and Early Pleistocene. A temperature contrast across the Plio-Pleistocene boundary is not clear-cut due to the faunal similarity of the 50 m and the 30 m Complexes. Significantly, about 50 per cent of the fauna is extinct. Decreased diversity and the appearance of *Choromytilus meridionalis* in the 30 m Complex may indicate cooling in the Early Pleistocene. Subsequently, the restriction of warmer waters to the north led to the establishment of the modern west-coast fauna. Lack of a broader regional database precludes more precise conclusions at this stage.

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INTRODUCTION

The fossil mollusc occurrences on the west coast of South Africa have received scattered attention during the past 50 years, with reports becoming more numerous in the last decade. Haughton (1932) presented an overview of the west-coast deposits and described several of the fossil molluscs. Barnard (1962) listed all the known Late Tertiary and Pleistocene molluscs from South Africa. New species and records for the west coast have since been added by Carrington & Kensley (1969), Kilburn & Tankard (1975), and Kensley (1972, 1977).

Diamond-mining activities on the Namaqualand coast have exposed coastal marine deposits in several areas. Fossil molluscs from three localities, Koingnaas, Swartlintjiesrivier, and Strandfontein, were the subject of the paper by Carrington & Kensley (1969). Material recorded in the present paper also comes from Koingnaas, plus two additional properties, Avontuur A, and Hondeklip (Fig. 1A, B). Exposures of several fossil-bearing beds were bulk-sampled, while selective sampling was carried out when appropriate.

The bulk of the material recorded in the accompanying list (Table 1) is housed in the South African Museum, as are holotypes and paratypes, which bear SAM-PQ catalogue numbers. Where possible, paratypic material has also been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. and bears USNM catalogue numbers.

GEOLOGICAL SETTING

This paper is a sequel to that of Carrington & Kensley (1969) in which several new species obtained from similar deposits were described and a summarized general account of the Cenozoic coastal Namaqualand stratigraphy was presented. Important observations recorded in that work were the recognition of two distinct littoral marine complexes, the 45–50 m and the 17–21 m transgression complexes, and their zone fossils *Donax haughtoni* Carrington & Kensley, and *Donax rogersi* Haughton, respectively. The complex names indicate perceived transgressive altimetric maxima. The older 45–50 m complex was considered typified by fine, green quartzose sands and the associated thin-shelled *D. haughtoni*, while the younger 17–21 m complex was characterized by brown-stained, coarse, quartzo-feldspathic sands, high-energy bedforms, and the robust *D. rogersi*. An evolutionary relationship was inferred between the two *Donax* species, and linked to the changed environment implicit in the contrasted lithologies of the two complexes. Additionally, species obtained from the 45–50 m complex suggested a fauna of warm-water affinity.

Subsequent fieldwork on the properties of Hondeklip and Avontuur A has furnished more information on the depositional environments, ages, and sea-level history of the 45–50 m and 17–21 m complexes. This work will be presented in detail in another article (Pether in prep.); thus only a condensed account is given here. Modifications of the succession presented by Carrington & Kensley (1969) are shown in the following summarized stratigraphy.

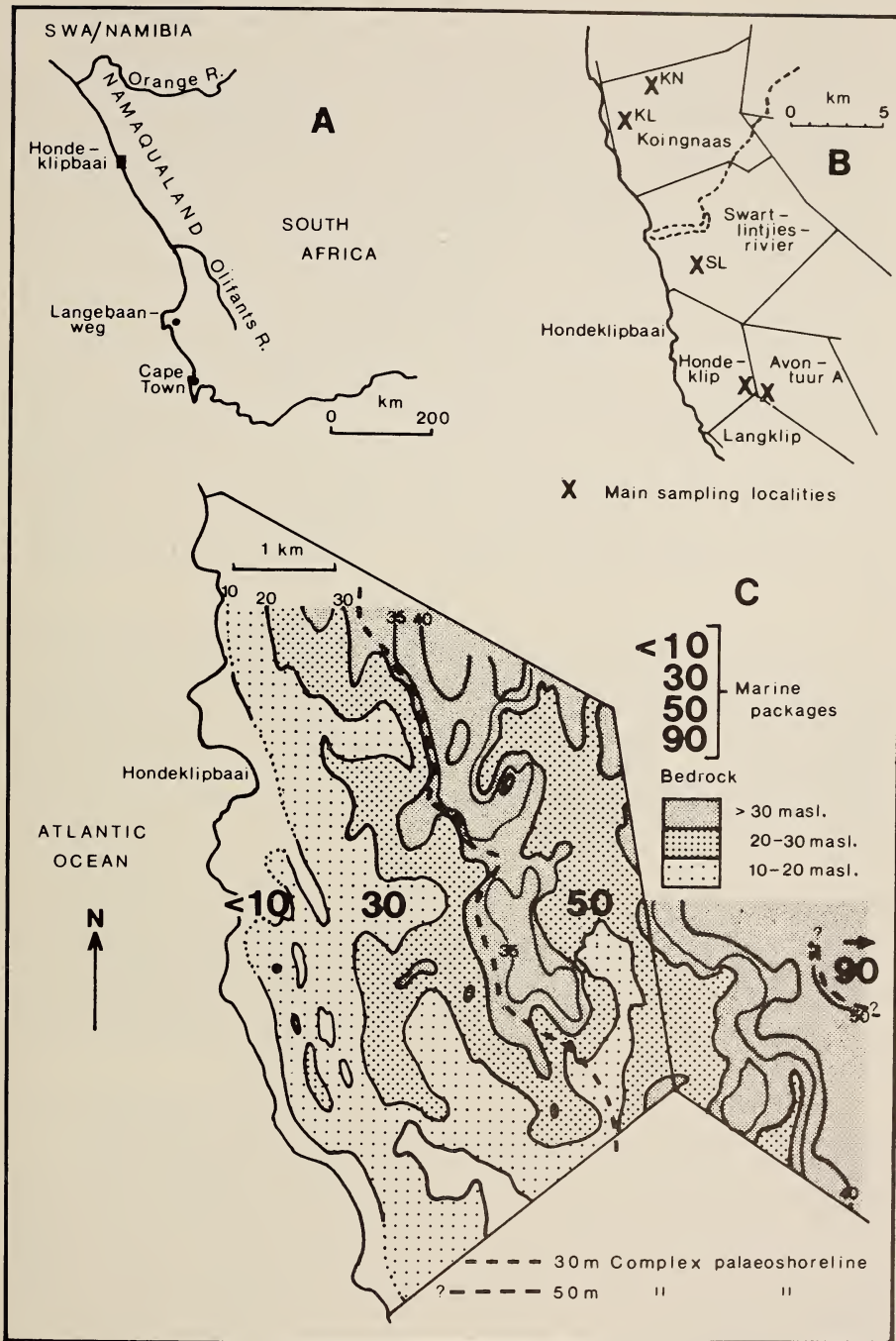


Fig. 1. A. Locality map. B. Hondeklip and surrounding properties with main sampling areas indicated. C. Bedrock contour map of Hondeklip and a portion of Avontuur A in metres above sea-level (masl). Large numerals (90, 50, 30) indicate the overlying deposits of the marine complexes; < 10 refers to the low-elevation, Mid-Pleistocene to Holocene raised beaches. Palaeoshorelines at transgressive maxima of the 30 m and 50 m Complexes are shown.

<i>Succession</i>	<i>Age</i>
*2 metre Beach	Holocene
*5 metre Beach	Late Pleistocene
8 metre Beach	Middle Pleistocene
30 metre Complex	Early Pleistocene
Regressive complex (incl. 29–34 m Beach and 17–21 m Complex)	
50 metre Complex	Late Pliocene
Regressive complex (= 45–50 m Complex)	
90 metre Complex	Early Pliocene
Regressive complex? (= 75–90 m Complex)	
(Includes lower shoreface to offshore deposits preserved in bedrock depressions underlying the 50 m Complex at lower elevations.)	
Kaolinized fluvial deposits	Latest Oligocene to Early Miocene
Bedrock	Archaean

THE HONDEKLIP AND AVONTUUR A DEPOSITS

Bedrock

The bedrock consists of Archaean quartzo-feldspathic gneiss, and bedrock topography (Fig. 1C) has profoundly influenced the local character of the overlying deposits. A major feature in the study area is a broad, coast-parallel, channel-like structure in the bedrock, which has its western flank defined by a bedrock ridge. Emergence of the bedrock ridge during regression resulted in a barrier along the seaward flank of the channel, protecting the channel area from open-coast conditions.

Kaolinized fluvial deposits

This, the oldest sedimentary entity encountered, is locally preserved in a bedrock depression. It is the remains of a fluvial arkosic infill deposited in the bedrock channel. The underlying bedrock and this fluvial infill are kaolinized and associated with it are silcrete slabs and boulders that are indurated portions of the fluvial deposits that have been exhumed by extensive erosion.

The bedrock is considered to have been incised during the major Oligocene regression that has been identified in the offshore record (Siesser & Dingle 1981). Subsequently, infilling Late Oligocene to Earliest Miocene fluvial deposits were kaolinized during the Early Miocene under tropical conditions; within the weathering profile titanium-rich silcrete developed. Sea-level fluctuations and concomitant marine and fluvial erosion during Middle Miocene to Late Pliocene times exhumed and modified the bedrock channel. No Miocene marine deposits are preserved.

* After Hendey & Volman (1986)

The 90 m Complex deposits

This high elevation complex, the 75–90 m Complex of Carrington & Kensley (1969), is present between 50–90 m above sea-level (masl), but no exposures at these elevations exist in the study area. However, underlying the younger 50 m Complex in a local bedrock depression, is a remnant deposit that may have been deposited, wholly or in part, during the same sea-level cycle. This is a partly indurated, mouldic, coquinoïd, muddy conglomerate, which exhibits extensive (though not laterally continuous), authigenic phosphorite (microsphorite) deposition. A ubiquitous, similar, phosphorite gravel content in overlying 50 m Complex gravels indicates the erosion of this previously more extensive lithology.

Fragmentary, worn, phosphate-mineralized, marine and terrestrial vertebrate fossils are associated with this bed. These have a Mio-Pliocene aspect (Q. B. Hendey pers. comm.). The mouldic coquinoïd fauna has both intertidal and offshore aspects. The bed is considered to have been storm-deposited in a lower shoreface to offshore environment during regression, in an embayed situation. Extensive microspherite precipitation driven by upwelling took place during calmer periods. This bed has previously been referred to as 'lower E stage' (e.g. Tankard 1975*b*, 1975*c*).

The 50 m Complex deposits

This complex is present mainly to the east of the bedrock ridge (Fig. 1C). Exposures in open-coast situations reveal a regressive vertical facies sequence of lower-shoreface, upper-shoreface, foreshore, and aeolian environments. The basal gravel is seen to be a transgressive veneer, which has been redeposited and supplemented during regression in a lower-shoreface context. The bedrock ridge promoted the development of back-barrier environments in its landward lee during regressive emergence.

Evidence of a minor transgressive sea-level fluctuation is preserved in this complex and consists of a laterally persistent surface produced in back-barrier deposits, an anomalously thick foreshore deposit, a vertical aspect to normally lateral open-coast barrier facies deposition, and a tidal inlet-dominated barrier overlying back-barrier deposits.

The 30 m Complex deposits

The 50 m Complex was eroded by a subsequent transgression and overlying the transgressive disconformity is the 30 m Complex. This is a seaward-thickening wedge, which, beneath foreshore deposits extending from the transgressive maximum near +30 m, progressively incorporates upper-shoreface, and then lower-shoreface deposits. This complex is preserved mainly to the west (seaward) of the bedrock ridge (Fig. 1C). Sea-level altitude relative to bedrock topography suggests that generally during 30 m Complex times the effect of bedrock topography was not as marked as during the previous sea-level cycle. In the study

area there is no evidence of back-barrier environments during 30 m Complex times.

The 30 m Complex subsumes the 17–21 m Complex and the 29–34 m Beach of Carrington & Kensley (1969). No evidence of a stillstand at *c.* 20 masl is present in Hondeklip exposures. Instead, 30 m Complex lower-shoreface gravels extend seawards from that elevation. However, the possibility that stillstands occurred subsequently during the regression cannot be dismissed at this stage. The complex is present almost up to the modern coastline, where it is overlapped by younger palaeoshorelines at elevations of less than 10 masl.

Age of the marine complexes

Onshore and offshore evidence of Tertiary sea-levels around southern Africa has been synthesized in a curve by Siesser & Dingle (1981) (Fig. 2A); this curve exhibits a general correspondence with the trends of global sea-level produced by Vail & Hardenbol (1979). Sea-level history and age inferred for the deposits at Langebaanweg (Fig. 2B) is consistent with the global sea-level record (Hendey 1981*a*, 1981*b*) and, pointing out the feasibility of altimetric correlation along the southern-African west coast, Hendey proposed a preliminary correlation scheme between Langebaanweg and west-coast localities involving the high-elevation (> 10 masl) deposits.

The correlation scheme was related to the sea-level curve of Vail & Hardenbol (1979). Beard *et al.* (1982) provided greater resolution for the Quaternary portion of the 'Vail curve' (sea-level cycles Q1 to Q8 (Fig. 2C)). Although methodological aspects and the chronology of the curve are controversial, it is accepted here as presented and considered to be of provisional utility. For example, Vail & Hardenbol (1979) and Beard *et al.* (1982) placed the Plio-Pleistocene boundary at 2,8 Ma; in contrast, in terms of the most recent ICS decision (Aguirre & Pasini 1985), the boundary at the Vrica section is ~1,64 Ma. Regardless of this controversy, it is the sea-level curves, as gross indicators, that are deemed relevant, and interestingly they do show a general correspondence with our present (though scant) knowledge of west-coast deposits. In this paper the Plio-Pleistocene boundary is taken at ~1,6 Ma; thus sea-level cycle Q1 (Fig. 2C) is considered Late Pliocene.

An important feature of Hendey's (1981*a*, 1981*b*) correlation scheme was the correlation of the 90 m Complex in Namaqualand with the Early Pliocene Varswater Formation at Langebaanweg; the latter, in turn, related to the transgressive sea-level period TP1 of Vail & Hardenbol (1979) (Fig. 2B). An Early Pliocene age for the 90 m Complex is consistent with observations at Hondeklip. The likelihood of the complex being a regressive package in Namaqualand suggests correlation with sea-level cycle TP2.

The presence of a species of *Equus* in the 50 m Complex suggests that it cannot be older than the 1,9 Ma mammalian dispersal event in Africa (Lindsay *et al.* 1980). Similar to the age inferred by Hendey (1981*a*) for the Baards Quarry Fluvial Deposits in the south-western Cape which contain *Equus*, the 50 m

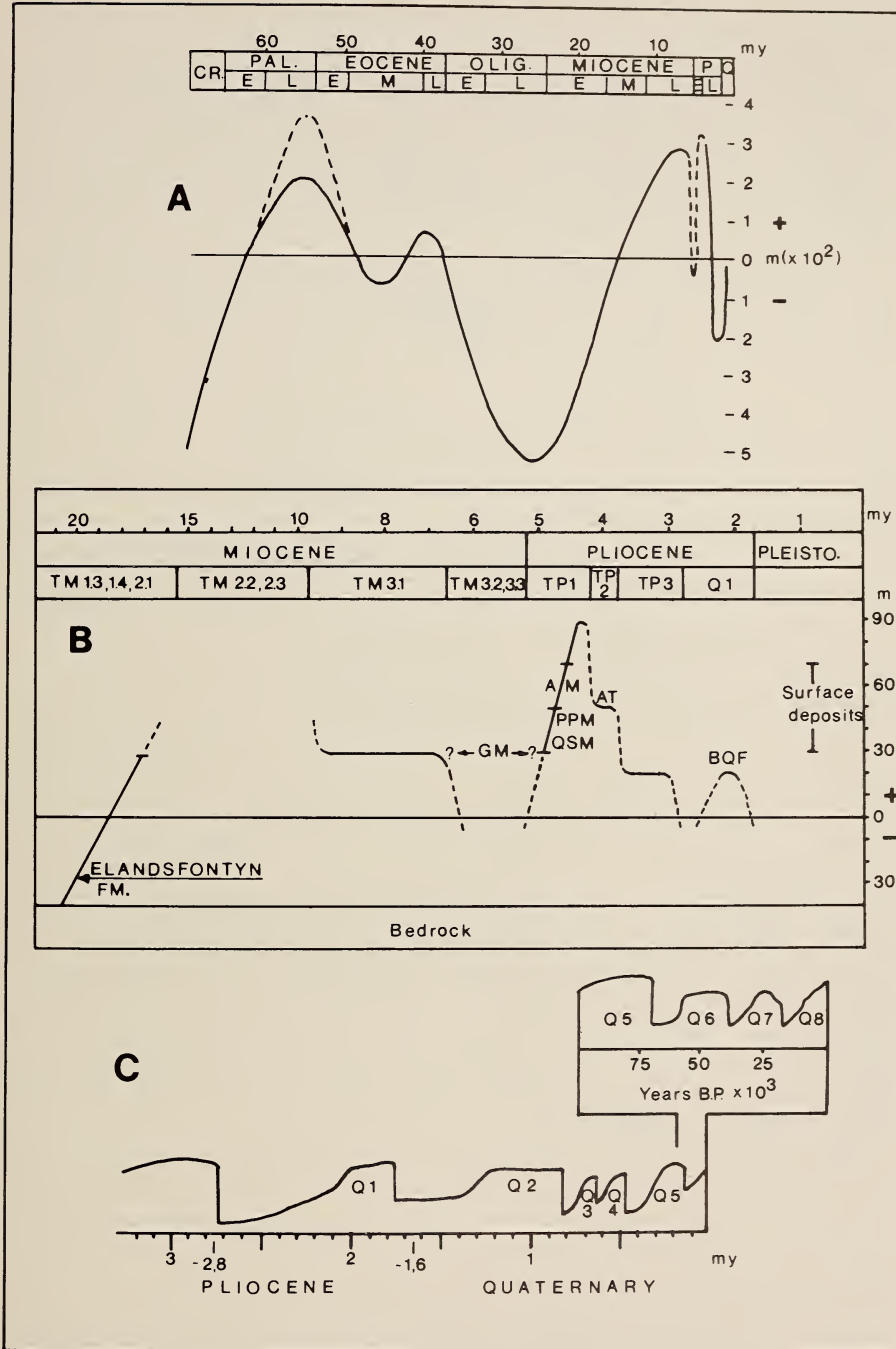


Fig. 2. A. Gross Tertiary sea-level trends after Siesser & Dingle (1981). B. Langebaanweg deposits (south-western Cape) related to global sea-level trends of Vail & Hardenbol (1979) (after Hendeny 1981b). GM = Gravel Member, QSM = Quartzose Sand Member, PPM = Pelletal Phosphorite Member, AM = Anyskop Marine Deposits—all of the Varswater Formation. AT = Anyskop terrestrial deposits, BQF = Beard's Quarry fluvialite deposits. C. Gross Quaternary sea-levels of Beard *et al.* (1982).

Complex is considered Late Pliocene in age and is correlated with the regressive portion of sea-level cycle Q1 of Vail & Hardenbol (1979) and Beard *et al.* (1982).

The 30 m Complex must reflect a subsequent high sea-level, and it is thus correlated with cycle Q2 in the Early Pleistocene. A Late Pliocene and Early Pleistocene age for the 50 m and 30 m Complexes, respectively, is probably consistent with the warmer-water faunal elements present, relative to the colder-water assemblages of the younger, low-elevation complexes and of the modern coast.

The age of these low-elevation (< 10 masl) palaeo-shorelines has recently been assessed (Hendey & Volman 1986). Fossil evidence associated with the 8 m Beach at Saldanha suggests a late Early Pleistocene age to Hendey & Cooke (1985) and it was correlated with sea-level cycle Q2. Since this report prefers to relate the 30 m Complex to cycle Q2, the 8 m Beach is here considered to reflect cycle Q3. This younger (Middle Pleistocene) age is inconsistent with the age constraints inferred from the fossil evidence at Saldanha, an issue yet to be resolved. The 5 m and 2 m shorelines are considered to be Late Pleistocene (Eemian) and Holocene respectively (Hendey & Volman 1986). Flemming (1977) has submitted evidence that the Flandrian transgression reached 3 masl and profoundly influenced the development of the Langebaan lagoon. Recently a radiocarbon date of 3800 BP has been obtained at 2,5 masl at Verlorelei (J. Parkington pers. comm.).

THE KOINGNAAS AND SWARTLINTJIESRIVIER LOCALITIES

Some basal exposures of the deposits on De Beers properties neighbouring Hondeklip (Fig. 1B) were examined and seen to contain molluscs not well represented at Hondeklip. In the case of the 50 m Complex outcrops (Koingnaas KN and Swartlintjies SL), this is due to the occurrence of thicker, muddy, distal lower shoreface deposits in bedrock depressions at these localities. At Hondeklip the deposits of this environment are thinner and more cryptic, due to the embayed palaeocoastal geomorphology formed by the bedrock topography, in contrast to the more open-coast, palaeocoastal situation considered applicable to the De Beers properties. This facies overlies bedrock or local 90 m Complex remnants, and is overlain by gravelly, proximal lower shoreface deposits of the 50 m Complex. It is characterized by a molluscan fauna with both intertidal and sublittoral components, and in these respects the similarity with the 90 m Complex remnants is noteworthy.

An outcrop of the 30 m Complex on Koingnaas also yielded species not encountered at Hondeklip (Koingnaas KL). At this exposure a massive sand, containing thin gravel beds and a mud lens ~20 cm thick, overlies bedrock at 10 masl. It attains its greatest thickness (~2 m) in a local bedrock depression. This unit is overlain by the 30 m Complex upper shoreface facies. It is thus interpreted as 30 m Complex proximal lower shoreface deposits. The open-coast forms *Isognomon* sp., *Mactra* sp., and *Turritella carinifera* dominate the assemblage.

SYSTEMATIC DESCRIPTIONS

In the following section, in addition to the previously undescribed material, discussion is given to some previously recorded taxa, where relevant.

As is frequently the case in fossil molluscan systematics, generic allocation cannot always be done with certainty, due to the lack of essential diagnostic information (e.g. radular and opercular structure). This uncertainty in generic placement was constantly in the forefront of the authors' thoughts when writing descriptions; nevertheless it was decided not to indicate this uncertainty with quotation marks or any other such device.

Unless otherwise stated, all material mentioned in this work was collected by the authors.

Class GASTROPODA

Family *Haliotidae**Haliotis saldanhae* Kensley, 1972

Haliotis saldanhae Kensley, 1972: 176, fig. 2.

Material

SAM-PQ-AV229, several fragments, Avontuur A, Trench 3.

SAM-PQ-KN370, numerous fragments, including seven triangular fragments, each the upper columella portion of an individual shell, Koingnaas KN-1.

Previous records

Langebaanweg, Pliocene.

Remarks

Several large abalone specimens have been seen in situ at Avontuur, but the shell material is usually so fragile and friable as to make recovery almost impossible. Several fragments of shell, however, have been recovered, bearing the distinctive rounded spiral ridges and broadly rounded oblique axial ridges characteristic of *H. saldanhae*.

A single specimen (SAM-PQ-AV506), c. 60 × 140 mm, was recovered, which retains its overall shape and proportions. Unfortunately none of the exterior shell structure remains, making positive identification impossible. The size of this specimen places it well beyond the maximum for *H. spadicea* Donovan, 1808, but within the size range of living *H. midae* Linnaeus, 1758, of the west coast.

Family *Fissurellidae**Amblychilepas scutellum* (Gmelin, 1791)

Amblychilepas scutella: Barnard, 1962: 191; 1963: 286, figs 21b, 22d-f.

Amblychilepas scutellum: Kilburn & Rippey, 1982: 35, pl. 2 (fig. 11), pl. 6 (fig. 1a, b).

Material

SAM-PQ-HB319, 4 specimens; TL 22,5 mm, 23,3 mm, 29,0 mm, 1 damaged, Hondeklip Zone 12. SAM-PQ-HB74, 2 specimens, Hondeklip, 50 m Complex.

Previous records

Living: Angola to Natal.

Fossil: Saldanha, Little Brak River, Sedgefield, Durban, Inhambane.

Remarks

The living subspecies, *A. s. scutellum* of the west coast, is characterized by the possession of 'moderately to extremely raised ends' (Kilburn & Rippey 1982: 35). The present material consists of six specimens not at all saddle-shaped, i.e. sitting flat on a horizontal surface, and one specimen with very slightly raised ends.

Fissurellidea aperta (Sowerby, 1825)

Pupillaea aperta Sowerby, Barnard, 1962: 191.

Fissurellidea aperta (Sowerby) Barnard, 1963: 288, fig. 21e. Kensley, 1973: 32, fig. 46. Kilburn & Rippey, 1982: 36, pl. 3 (fig. 3), pl. 6 (fig. 13).

Material

SAM-PQ-KN507, 1 specimen, 22,8 × 12,8 mm, 4 fragments, Koingnaas KN-1.

Previous records

Living: Namibia to Transkei, shallow infratidal.

Fossil: Pleistocene, Algoa Bay.

Tugali barnardi (Tomlin, 1932)

Tugalia barnardi: Barnard, 1963: 300, figs 21d, 22a-c.

Material

SAM-PQ-KN392, 2 specimens, 4,0 × 2,8 mm, 8,1 × 4,6 mm, Koingnaas KN-1.

Previous records

Living: off Cape Point, 360 m; False Bay, 18 m; St. Francis Bay, 12 m.

Dead: Cape Point to Cape Morgan, intertidal to 360 m.

Remarks

The fossil specimens have been compared with material in the South African Museum, and agree very closely with specimens from St. Francis Bay (SAM-A9299). The external ridge sculpture is as figured by Barnard (1963: 291, fig. 22b).

Family Patellidae

Patella hendeyi sp. nov.

Figs 3, 4

Patella sp. ('large') Haughton, 1932: 30.*Material**Holotype*. SAM-PQ-AV454, 126 × 107 mm, Avontuur A, 50 m Complex.*Paratypes*. SAM-PQ-AV455-457, 7 specimens, 68 × 57 mm, 74 × 61 mm, 90 × 76 mm, 94 × 77 mm, ? × 109 mm, 142 × 133 mm, 146 × 137 mm, Avontuur A, 50 m Complex. SAM-PQ-HB458, 148 × 130 mm, Hondeklip Z4A, 50 m Complex (with attached barnacle shells). USNM 400979, 2 specimens, 122 × 112 mm, 138 × 122 mm, Avontuur A, 50 m Complex.

Fig. 3. *Patella hendeyi*. Holotype in dorsal view.
Scale = 30 mm.



Fig. 4. *Patella hendeyi*. Holotype in upper right corner, remainder of specimens paratypes. Scale = 30 mm.

Non-type material. SAM-PQ-AV459, 4 damaged and incomplete specimens, Avontuur A. SAM-9921, 2 specimens, 106 × 91 mm, 98 × 85 mm, Graauweduinen, Vanrhynsdorp District coast, Cape Province, coll. H. Harger. SAM-9932, 136 × 124 mm, Graauweduinen, Vanrhynsdorp District coast, coll. H. S. Harger.

Description

Shell heavy, relatively low, with subcircular outline, only slightly longer than wide, with apex anterior to midline, apex in all specimens eroded. Sculpture consisting of fine radial lines of subequal strength (about 300 on circumference of holotype, 200–300 in paratypes), becoming divided and/or distorted close to circumference. No juvenile scars on any specimens.

Remarks

The specimens numbered SAM-9921 and 9932 are those referred to by Haughton (1932: 30) as '*Patella* sp. (large)'

Of present-day patellids living on the southern African coast, in terms of size, only *P. tabularis* Krauss, 1848, reaches the size of the largest specimen considered here. This species, however, characteristically has very large acute radiating ribs alternating with weaker ribs, and an irregular shell margin.

Patella safiana Lamarck, 1819, of West Africa has more regularly spaced but stronger ribs.

Patella argenvillei Krauss, 1848, has a narrower and higher shell.

Only very large shells of *P. granularis* Linnaeus, 1758, approach the present material in shape and sculpture. Prof. G. Branch (U.C.T.) has donated a specimen of *P. granularis* (91,0 × 74,9 mm), that in shape closely resembles some of the smaller of the present fossils, and has faint radial sculpture as in the largest fossil. The possibility exists that *P. hendeyi* represents either a precursor of *P. granularis* or an earlier and much larger form of the same species.

Patella (Ancistromesus) fuenzalidai Herm, 1969, from the Pliocene of central Chile, bears a striking resemblance to the present species. The holotype and paratype of this species, at 209 mm and 188 mm length, are even larger than specimens of *P. hendeyi*, but have a very similar outline and general proportions and also the very fine radiating ribs seen in the Namaqualand species.

Etymology

The species is named for Dr Q. B. Hendey of the South African Museum.

Patella hoffmani sp. nov.

Figs 5, 6

Material

Holotype. SAM-PQ-AV508, 56,7 × 51,0 × 31,0 mm (length × width × height), Avontuur A.

Paratypes. SAM-PQ-AV402, 9 specimens, 23,3 × 18,9 × 8,3 mm; 32,3 × 27,8 × 10,6 mm; 34,8 × 31,4 × 13,8 mm; 42,9 × 38,5 × 15,8 mm;

44,5 × 41,0 × 20,0 mm, 47,7 × 43,6 × 22,4 mm; 47,3 × 42,9 × 20,0 mm; 46,7 × 41,8 × 25,4 mm; 54,2 × 48,2 × 30,8 mm; Avontuur A. SAM-PQ-HB188, 48,4 × 41,2 × 27,1 mm, Hondeklip, 50 m Complex. SAM-PQ-HB191, 2 specimens, 48,5 × 41,9 × 23,0 mm; 51,6 × 45,8 × 26,7 mm; Hondeklip, 50 m Complex. SAM-PQ-HB142, 3 specimens, 39,7 × 32,0 × 18,7 mm; 46,9 × 38,8 × 21,7 mm; 47,7 × 40,2 × 25,6 mm; Hondeklip, 50 m Complex. SAM-K4755, 49,5 × 46,0 × 24,1 mm; Swartlintjies SL2, coll. A. J. Tankard. SAM-PQ-HB509, 3 specimens, 43,8 × 40,4 × 32,3 mm; 49,4 × 45,0 × 29,8 mm; 51,2 × 44,1 × 34,5 mm; Hondeklip Zone 4C, 50 m Complex. USNM 400980, 6 specimens, ? × 37,2 × 18,4 mm; 42,2 × 38,5 × 17,0 mm; 44,4 × 39,4 × 18,6 mm; 45,8 × 40,6 × 27,5 mm; 52,3 × 47,5 × 31,1 mm; 54,3 × 49,0 × 25,3 mm; Avontuur A, 50 m Complex.

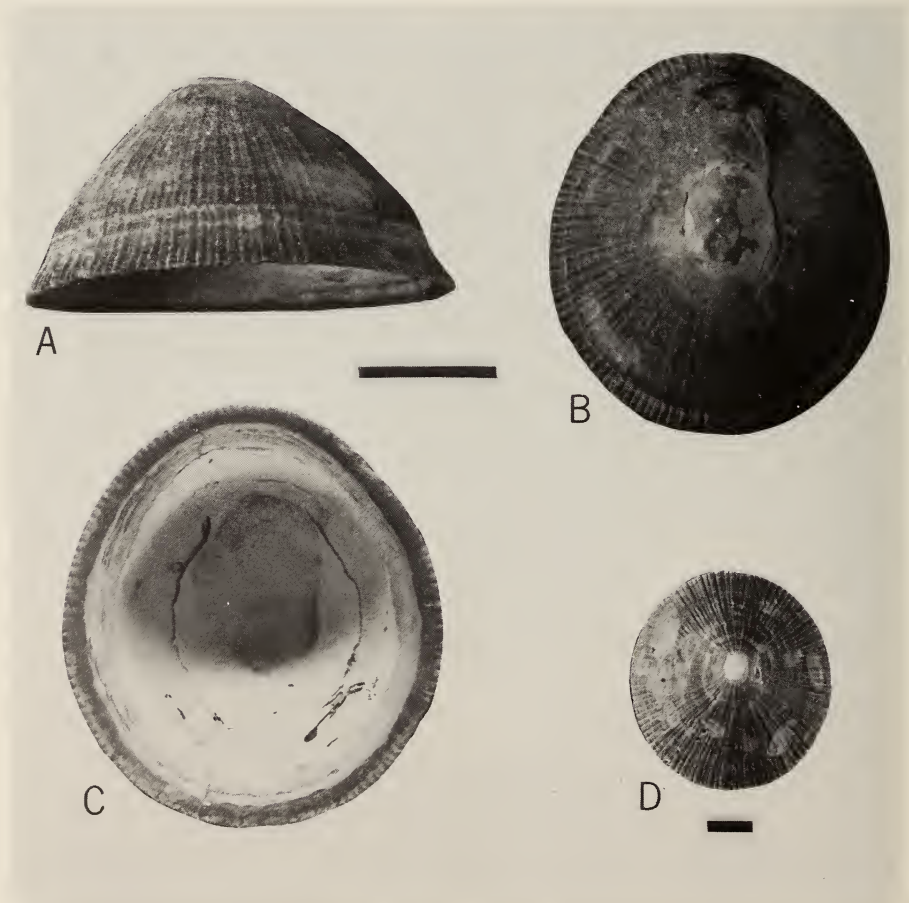


Fig. 5. *Patella hoffmani*. A-C. Lateral, dorsal and ventral views of holotype. Scale = 20 mm. D. Specimen showing juvenile scars. Scale = 10 mm.

Non-type material. SAM-PQ-HB249, 4 specimens, Hondeklip, B Block, 50 m Complex. SAM-PQ-AV402, 12 specimens, Avontuur A, 50 m Complex. SAM-PQ-AV510, 4 specimens, Avontuur A, 50 m Complex. SAM-K4754, 3 specimens, Koingnaas, coll. A. J. Carrington. SAM-K4756, 2 specimens, Somnaas SM4, 50 m, coll. A. J. Tankard. SAM-PQ-HB461, 27 specimens, Hondeklip, Zone 4C, 50 m Complex.

Description

Shell generally high-conical; length/width ratio range 80–93 per cent; sides very faintly convex; apex at or close to midpoint of antero-posterior line. Sculpture consisting of radiating flattened ribs of equal strength; under magnification, ribs seen to be built up of numerous concave growth lines,

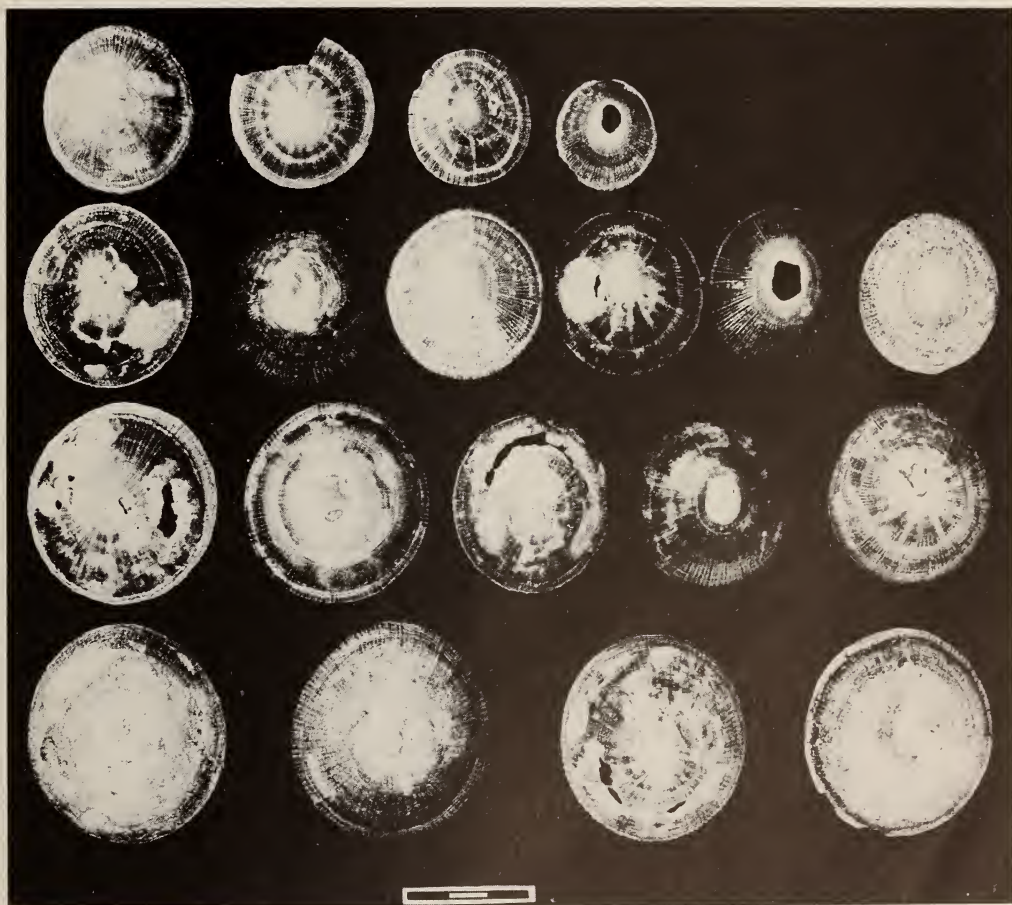


Fig. 6. *Patella hoffmani*. Range of specimens in dorsal view, some showing colour-rays. Scale = 30 mm.

somewhat flattened, separated by shallow sharp groove. Number of ribs on circumference of large specimens ranging from 105 to 124. Shell margin finely and evenly serrate. Large shells often with several oval juvenile scars, up to nine per shell; scars usually 4–10 mm greatest diameter. Some shells bearing dark-brown radiating bands separated by narrow pale bands; dark rays more distinct closer to shell apex; near margin, dark bands coalescing to form continuous dark-brown band.

Remarks

The almost circular circumference and tall conical shape of *Patella hoffmani* bears little resemblance either to any of the living or fossil southern or West African patellids. The sculpture of equal flattened radiating ribs, however, is almost identical to that of *Patella argenvillei*.

The subcircular and high-conical shape of *P. hoffmani* is reminiscent of *Nacella clypeater* (Lesson, 1831) from Chile. This species, however, possesses fewer radiating ribs which, unlike the flattened ribs of *P. hoffmani*, are low and rounded.

Etymology

The species is named for Mr F. Hoffman, of Transhex Pty Ltd diamond company.

Family Trochidae

Clanculus lutosus sp. nov.

Fig. 7

Material

Holotype. SAM-PQ-KN511, 16,3 × 18,3 mm, outer lip damaged, Koingnaas KN-1.

Paratypes. SAM-PQ-KN512, 5 specimens, Koingnaas KN-1.

Non-type material. SAM-PQ-KN513, 12 damaged specimens, Koingnaas KN-1.

Description

Shell top-shaped, of at least 4 postnatal whorls. Whorl profile straight to barely convex. Sculpture of spiral lines bearing bead-like, close-set tubercles; second whorl with 4–6 spiral lirae; third whorl with 10–12 lirae; body whorl with 10 lirae above shoulder, 12–14 on base. Shoulder narrowly rounded. Umbilicus broadly open, smooth, with single low spiral ridge. Columella with bipartite tubercle on lower portion. Outer lip slightly thickened, but lacking internal plicae.

Remarks

Clanculus murrayi has been described from the Quaternary of the Hondeklipbaai area (Carrington & Kensley 1969). This species, while having beaded

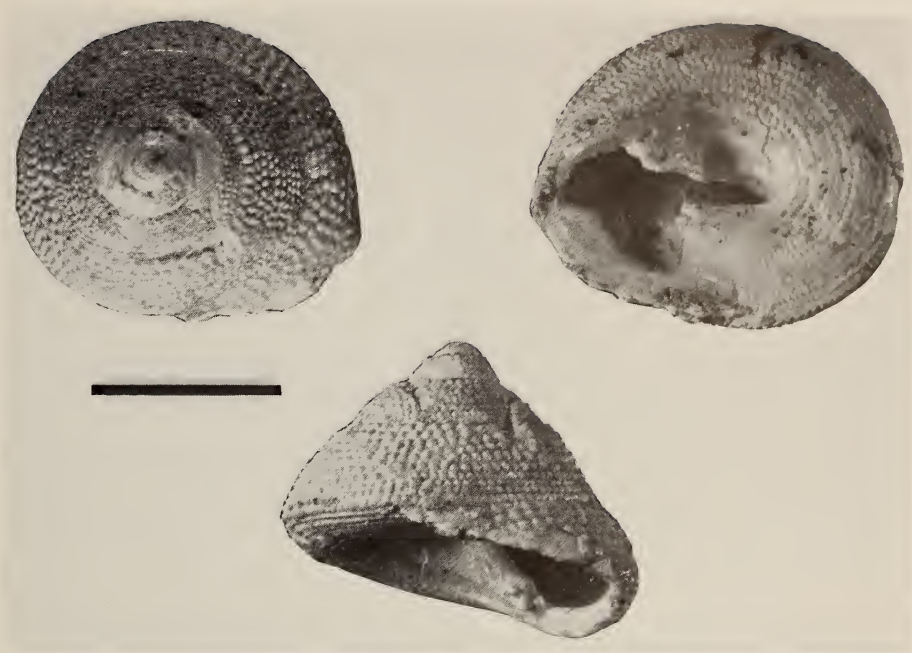


Fig. 7. *Clanculus lutosus*. Holotype. Scale = 10 mm.

spiral lirae as in *C. lutosus*, is characterized by a stepped profile, with two strong lirae on the whorl periphery.

Clanculus atricatena Tomlin, 1921, known from Transkei to Zululand, possesses a grooved lower tubercle on the columella, giving it a bipartite appearance. The spiral lirae of this species, however, are more finely beaded, while the outer lip possesses a strong posterior tubercle on the inner surface.

Clanculus kraussi Philippi, 1846, from West Africa, possesses finely beaded spiral lirae, but lacks the bipartite columella tubercle of *C. lutosus*. Two other West African species, however, show a stronger resemblance to the present material. *Clanculus santamariae* Gofas, 1984, from Benguela, Angola, has spiral lirae with fewer but larger beads, a crenulate umbilical opening, and a non-bifid columella tooth. *Clanculus pseudocorallinus* Gofas, 1984, also from Benguela, Angola, possesses sculpture very similar to that of *C. lutosus*, but also has a crenulate umbilical opening, and a non-bifid columella tooth. *Clanculus corallinus* (Gmelin, 1790) of the Mediterranean has fewer spiral lirae with larger beads, but does have a bifid columella tooth, and a non-crenulate umbilical opening as in *C. lutosus*.

Etymology

The specific name is derived from the Latin 'lutosus', muddy, and refers to the sediments from which the material was collected.

Gibbula zonata patula subsp. nov.

Fig. 8

Material

Holotype. SAM-PQ-HB514, 5,0 × 6,9 mm, body whorl damaged, Hondeklip Zone 3.

Paratypes. SAM-PQ-HB117, 4 specimens, 4,9 × 5,6 mm, 4,3 × 5,5 mm, 6,1 × 7,2 mm, 6,3 × ? mm, Hondeklip Zone 3. SAM-PQ-HB345, 6,8 × 6,5 mm, Hondeklip Zone 12.

Description

Shell broader than high, somewhat globular, of 4 whorls. Profile of whorls evenly rounded. Sculpture of rounded spiral bands; penultimate whorl with 6 bands; body whorl sculpture variable, with 8–10 bands on upper whorl; some specimens with intermediate finer lirae; ventral whorl with 8–12 lirae. Umbilicus broad, open in all specimens. Raised rounded bands in some specimens having darker colour than rest of shell.



Fig. 8. *Gibbula zonata patula*. Holotype in upper left corner, remainder of specimens paratypes. Scale = 3 mm.

Remarks

The present material is very similar to *Gibbula zonata* (Wood, 1828), known from the intertidal and shallow infratidal of South West Africa–Namibia to False Bay, Cape. The variable spiral sculpture of the present material agrees well with the living species. The umbilicus is usually closed in adults, but occasionally remains open in the living species, while all the fossil specimens have open umbilici. As the fossils come from a distinctly warm-water assemblage, and *G. zonata* is characteristically a cold-water species, it seems essential to regard the fossil as a chrono-subspecies, or as a precursor species of *G. zonata*.

Etymology

The specific name derives from the Latin 'patulus', standing open, and refers to the open umbilicus of the species.

Family Turbinidae

Bolma anoropha sp. nov.

Fig. 9

Material

Holotype. SAM–PQ–KN516, operculum, length 23,2 mm, Koingnaas KN–1.

Paratypes. SAM–PQ–KN517, 6 opercula, lengths 17,6, 20,0, 25,0, 26,0, 26,1 mm, one damaged, Koingnaas KN–1. SAM–PQ–SL518, operculum, length 12,9 mm, Swartlintjies SL–20.

Description

Operculum narrowly elongate-oval, narrower at apical end; internal surface gently convex, with numerous growth-lines. Apex on outer ventral margin. External surface smooth, with rounded ridge in dorsal half. Operculum thickest posterodorsally.

Remarks

None of the living southern African turbinids possesses an operculum resembling the present material. *Bolma andersoni* (Smith, 1902), known from Transkei to Zululand, possesses a more broadly oval operculum, but has similar features, i.e. a smooth external surface, posterodorsally thickset, and with the apex on the outer ventral margin.

Unfortunately, no turbinid shell that could be associated with these opercula has been found in the deposits.

Etymology

The specific name, from the Greek 'anorophos', without a roof, alludes to the fact that no shell has been found associated with the present opercula.



Fig. 9. *Bolma anoropha*. Holotype in upper left corner, remainder of specimens paratypes. Scale = 10 mm.

Family **Turritellidae***Turritella declivis* Adams & Reeve, 1850

Turritella declivis: Barnard, 1963: 167, fig. 33c. Kensley, 1973: 74, fig. 243.

Material

SAM-PQ-KN350, numerous fragments, up to 47 mm in length, maximum diameter 13 mm, Koingnaas KN-1.

Previous records

Living: False Bay, 51 m; off Cape St. Francis, 12–112 m.

Dead: False Bay to Agulhas Bank, East London, 12–248 m.

No fossil record.

Remarks

Most of the present material is unworn, and shows the straight, even profile of typical *T. declivis*. A few fragments show slight development of a cingulum above the suture, but none show the hollowing of the whorls seen in the *T. excavata* form (see Barnard 1963: 168).

Family **Crepidulidae***Calyptraea kilburni* nom. nov.

Fig. 10

Calyptraea aurita striata Carrington & Kensley, 1969: 201, fig. 2c, pl. 22. Kilburn, 1980: 194.

Material

SAM-K1433 (holotype of *C. aurita striata*), 8,1 × 19,6 mm, Swartlintjies, 45–50 m transgression. SAM-PQ-HB148, 2 specimens, 9,8 × 27,2 mm, one damaged, Hondeklip HB-4, 50 m Complex. USNM 400981, 2 specimens,

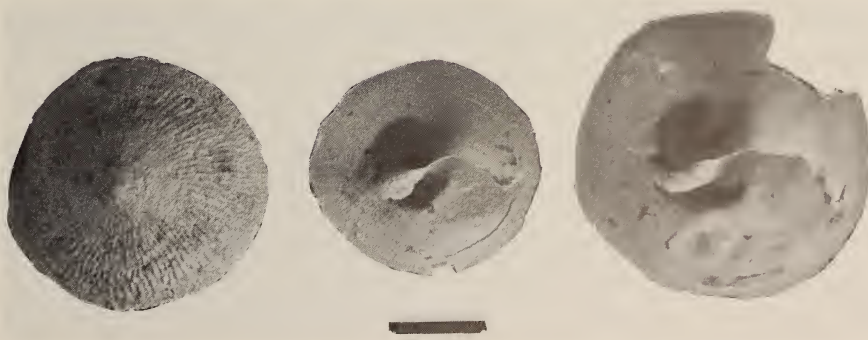


Fig. 10. *Calyptraea kilburni*. Left, dorsal view; centre and right, ventral view.
Scale = 10 mm.

9,0 × 23,3 mm, 11,4 × 30,4 mm, numerous fragments, Hondeklip, 50 m Complex.

Remarks

Kilburn (1980) correctly pointed out that the name '*striata*', used as a subspecific epithet by Carrington & Kensley (1969), was thrice preoccupied. Further, *C. aurita* (Reeve) from Chile differed markedly from the living South African species now named *C. barnardi* Kilburn, 1980. The west-coast fossil species, while having fine radiating striae similar to the Chilean *C. aurita*, differs in the structure of the septum. A new name is thus required for the Namaqualand fossil species.

Etymology

The species is named for Dr R. N. Kilburn of the Natal Museum, foremost southern African malacologist.

Crepidula deprima sp. nov.

Fig. 11

Material

Holotype. SAM-PQ-HB519, 22,6 × 9,2 mm, Hondeklip Zone 4A.

Paratypes. SAM-PQ-HB520, 2 specimens, 12,3 × 5,5 mm, 16,9 × 7,2 mm, 2 fragments, Hondeklip Zone 12. SAM-PQ-HB125, 1 specimen, 14,2 × 7,4 mm, Hondeklip HB-4. SAM-PQ-HB521, 3 specimens, 16,6 × 8,1 mm, 16,0 × 6,3 mm, 15,1 × 7,9 mm, 2 fragments, Hondeklip Zone 4A. USNM 400982, 1 specimen, 16,1 × 8,0 mm, 2 fragments, Avontuur A.

Description

Shell elongate-oval, strongly dorso-ventrally depressed, sides roughly parallel, anteriorly evenly rounded, dorsum convex in long axis, dorsal surface with irregular growth lines. Apex terminal on rounded posterior end. Ventral 'shelf' between posterior margin and start of septum. Free edge of septum evenly concave.

Remarks

Crepidula deprima bears little resemblance in its general shape and proportions to any of the southern or West African crepidulids. *Crepidula plana* Say, 1822, of the east coast of the U.S.A. is a similarly depressed species with a concave septum, but is much larger (up to 40 mm in length), with a narrowly rounded posterior end and a truncate anterior end.

Etymology

The specific name is derived from the Latin 'deprimo', depressed, and refers to the dorso-ventrally depressed condition of the present species.



Fig. 11. *Crepidula deprima*. A. Holotype in dorsal and ventral view. B. Paratypes. Scales = 10 mm.

Family Naticidae

Natica cf. *adansoni* (Blainville, 1824)

Fig. 12

Natica adansoni (Blainville), Nicklés, 1950: 80, fig. 117.

Material

SAM-PQ-KN522, 8 specimens, ? × 5,7 mm, 6,3 × 6,4 mm, 15,8 × 14,3 mm, ? × 15,2 mm, 18,2 × ? mm, 20,9 × 17,8 mm, 20,4 × 19,0 mm, 21,5 × ? mm, Koingnaas KL south face.

Previous records

Living: Madeira; Cape Verde Islands; Morocco to Angola.



Fig. 12. *Natica cf. adansoni*. Scale = 10 mm.

Description

Shell slightly wider than long; spire low. Umbilicus with slight ridge at outer margin; columella callus forming convex lobe or bulge in umbilicus. Single specimen with broad band of brown pigment stretching from above umbilicus on to base and anterior end of outer lip.

Remarks

As all the present specimens are to some degree abraded, a definite identification is difficult. The form of the umbilicus, however, most closely resembles that of *N. adansoni*. The presence of a band of pigment around the umbilicus and base, typical of the living species, further suggests this identification.

Sinum concavum (Lamarck, 1822)

Fig. 13

Sigaretus concavus Lamarck, Nicklés, 1950: 81, fig. 121. Paes da Franca, 1960: 16.

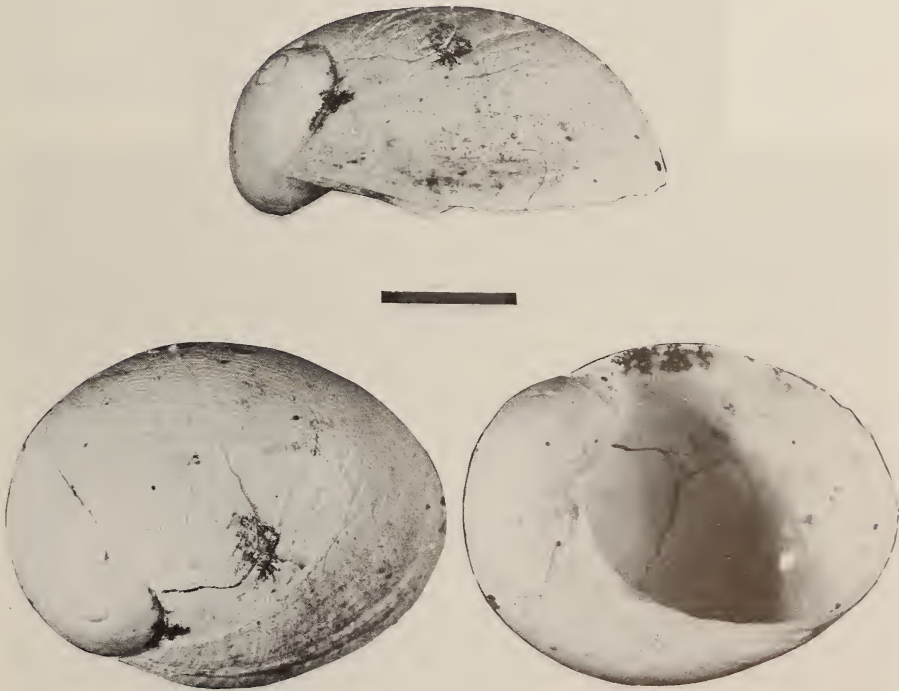


Fig. 13. *Sinum concavum*. Scale = 5 mm.

Material

SAM-PQ-HB515, longest diameter 16,8 mm, widest diameter 12,9 mm, Hondeklip B Block.

Previous records

Senegal to Moçâmedes, Angola.

Description

Shell thin, fragile. Protoconch indistinct; 4 postnatal whorls. Spire low, barely protruding above surface of body whorl. Sculpture consisting of low irregular flattened spiral lirae of varying widths, becoming obscure in columella area. Lirae +50 on body whorl, difficult to count as wider lirae tend to divide obscurely into several finer bands. Twenty-five lirae on penultimate whorl; obscure on earlier whorls.

Family Cymatiidae

Argobuccinum casus sp. nov.

Figs 14, 15

Material

Holotype. SAM-PQ-AV523, 89,9 × 50,9 mm, apex and base damaged; Avontuur A, 50 m Complex.

Paratypes. SAM-PQ-AV405, 3 specimens, 66,2 × 37,8 mm, 50,7 × 28,6 mm, 43,8 × 27,8 mm, Avontuur A, 50 m Complex. SAM-PQ-HB339, 4 specimens, 62,7 × 37,4 mm, 40,3 × 19,4 mm, 32,5 × 18,2 mm, 31,2 × 19,4 mm, Hondeklip Zone 12. SAM-PQ-AV524, 75,5 × 48,0 mm, 8 smaller specimens 48,8 × 21,9 mm to 29,0 × 15,8 mm, Avontuur A, 50 m Complex. USNM 400983, 2 specimens, 48,7 × 29,0 mm, 33,3 × 17,9 mm, Hondeklip Zone 12. USNM 400984, 58,9 × 32,9 mm, Avontuur A, 50 m Complex. USNM 400985, 4 specimens, 27,8 × 15,1 mm to 42,0 × 22,8 mm, Avontuur A, 50 m Complex.

Non-type material. SAM-PQ-AV525, 22 specimens, Avontuur A, 50 m Complex. SAM-PQ-HB526, 15 specimens, Hondeklip Zone 4A.

Description

Shell high-spired, very slightly dorso-ventrally compressed, with at least 5 postnatal whorls bearing a total of about 6 varices, latter not continuous from whorl to whorl. Profile of whorls evenly convex. Shell somewhat variable with regard to degree of elongation; few squatter specimens resembling *Argobuccinum pustulosum* (Lightfoot, 1786) in general proportions. Siphonal canal less than half length of aperture, slightly flexed to left. Outer lip with 11 or 12 ridges, becoming paired in older specimens. Columella smooth. Postnatal sculpture consisting of strong flattened spiral ridges or ribbons with narrow intervening grooves, 7 or 8 on earlier whorls, 13 to 15 on body whorl with finer alternating ridges appearing.



Fig. 14. *Argobuccinum casus*. A. Range of paratypes. Scale = 20 mm. B. Holotype. Scale = 10 mm.

Spiral ribbons becoming worn on body whorl, and seen to consist of 2 high ridges connected and covered by outer shell layer. Spiral ridges running on to dorsum of siphonal canal. Very faint rounded axial ridges seen in two specimens, 7 ridges between varices, becoming obsolete on body whorl.

Remarks

Of the cymatiids currently living on the west coast, *A. casus* most closely resembles *Argobuccinum pustulosum* (Lightfoot). This latter is said to occur in two forms or subspecies (see Kilburn & Rippey 1982: 75), with *A. pustulosum proditor* (Frauenfeld, 1865) being the west-coast form. *Argobuccinum casus* generally has a narrower shell even than this west-coast form, lacks the rounded tubercles on the spiral bands, has rounded tubercles rather than elongate ridges on the inner surface of the outer lip, has a more clearly defined siphonal canal, and lacks the short marginal digitiform projections of the lower outer lip. Even on the few specimens showing faint axial ribs, where these intersect the spiral bands, no rounded tubercles are formed as in the living species.

The present species was also compared with Pleistocene material of *A. pustulosum* (Lightfoot) from the Saldanha Bay area, and again, all the differences listed above are apparent.

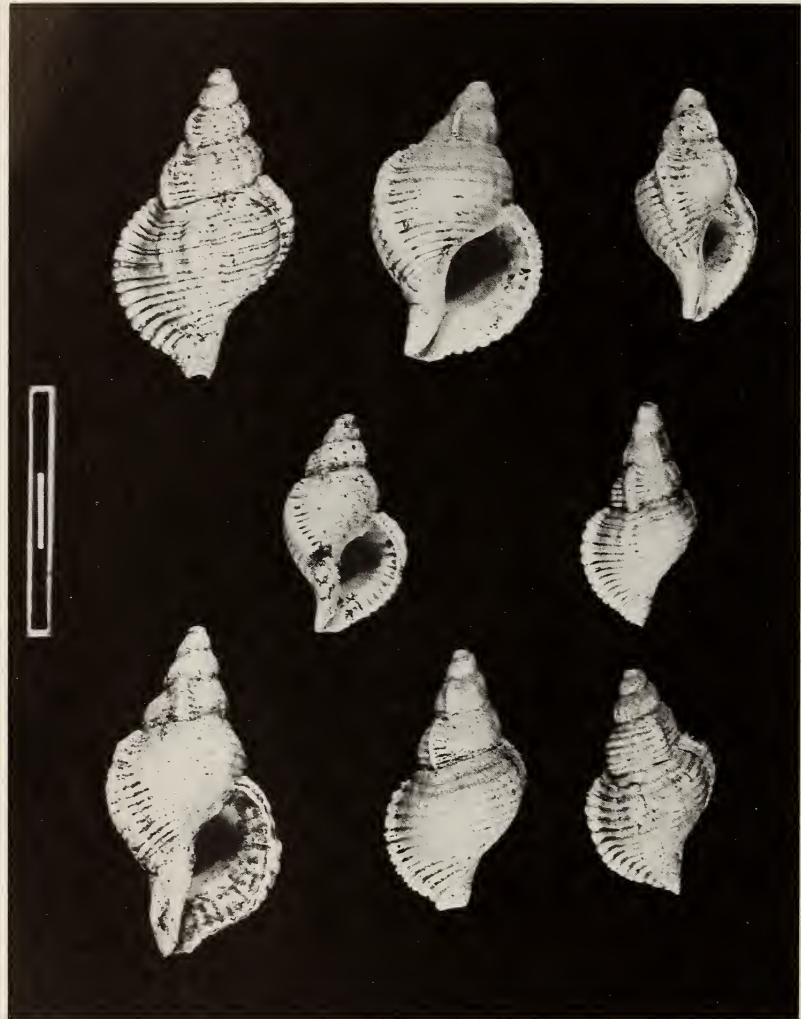


Fig. 15. *Argobuccinum casus*. Range of paratypes. Scale = 30 mm.

Cymatium parthenopeum (von Salis, 1793), living on the coasts of West and south-east Africa, and known as a fossil from the Pliocene of Italy, possesses fewer spiral bands, but stronger axial sculpture than *A. casus*.

Etymology

The specific name, the Latin for 'adventure', is derived from the farm-name Avontuur, a locality for the present species as well as several others described in this work.

Family Epitoniidae

Epitonium (Gyroscala) lycocephalum sp. nov.

Fig. 16

Material

Holotype. SAM-PQ-HB527, 14,5 × 6,6 mm, Protoconch damaged, Hondeklip Zone 4A, 50 m Complex.

Paratypes. SAM-PQ-HB528, 2 specimens, 13,0 × 5,0 mm (apex missing), 12,9 × 4,6 mm, Hondeklip Zone 12, 50 m Complex.

Non-type material. SAM-PQ-HB529, 15 fragments, Hondeklip A Block, 30 m Complex.

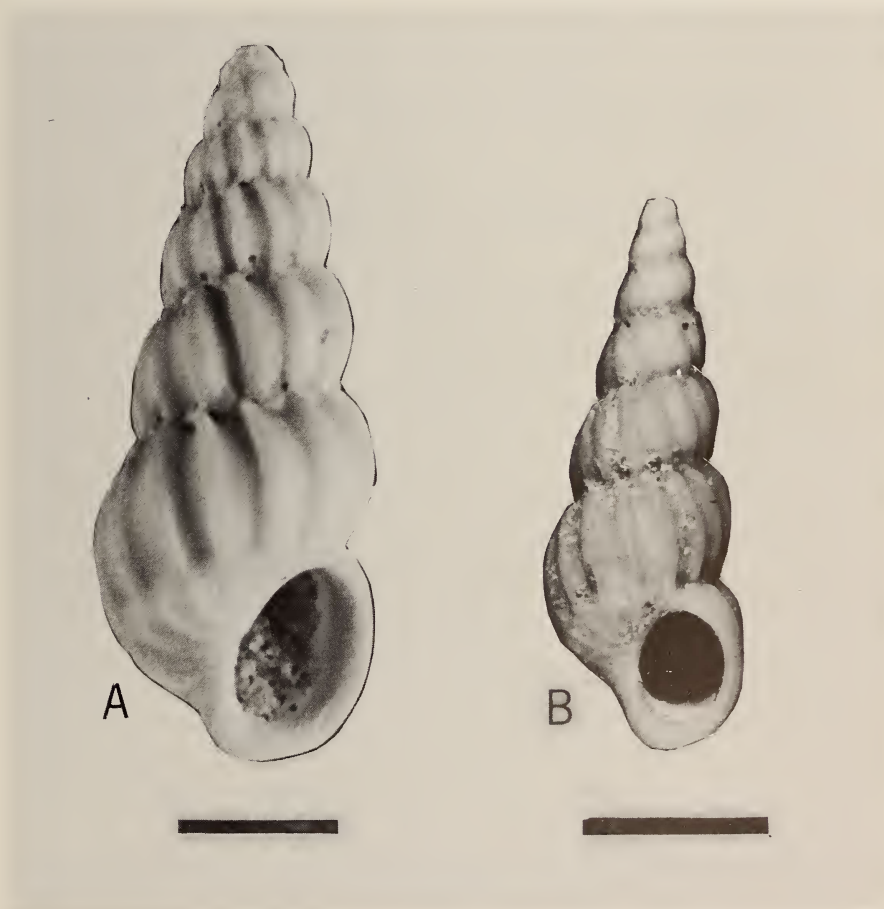


Fig. 16. *Epitonium lycocephalum*. A. Paratype. Scale = 3 mm.
B. Holotype. Scale = 5 mm.

Description

Protoconch unknown; at least 6 postnatal whorls. First whorl with 12–13 well-defined rounded lamellae; second to fifth whorls each with 15 lamellae; body whorl with 14 lamellae. At least 20 very fine spiral lines visible between lamellae, becoming obscure near upper and lower sutures, and difficult to count. Strong basal lira on body whorl. Suture crenulate. Outer lip varicoid.

Remarks

The present material resembles the living east-coast species *E. coronatum* (Lamarck, 1816) in the possession of a basal lira, but is more slender. The common *Epitonium* of the west coast, *E. kraussi* (Nyst), lacks both spiral lirae and a basal lira. *Epitonium lamellosum* (Lamarck, 1822) of West and South Africa is a somewhat broader shell, with fewer lamellae (9–10 on body whorl), and lacks distinct spiral sculpture.

Etymology

The specific name, from the Latinized Greek meaning 'wolf head', alludes to a low hill or koppie, Wolfkop, in the vicinity of Hondeklip Bay.

Family **Thaididae**

Nucella praecingulata (Haughton, 1932)

Figs 17, 18

Thais praecingulata Haughton, 1932: 48, pl. 5 (figs 6–10). Barnard, 1958: 219; 1962: 182.

Material

Syntypes. SAM-9730, 3 specimens, Reuning's Claim, Alexander Bay, Cape Province, coll. J. B. Cilliers. SAM-10598, 1 internal mould, The Point, Namaqualand coast, Cape Province, oyster horizon, coll. E. Reuning. SAM-9731, 4 specimens, Alexander Bay; SAM-9742, 1 specimen; SAM-9743, 1 specimen; SAM-9745, 1 specimen; SAM-9746, 1 specimen; SAM-9749, 1 specimen; SAM-9750, 1 specimen; SAM-9752, 1 specimen; SAM-9753, 1 specimen; SAM-9754, 1 specimen; SAM-9934, 7 specimens; all previous specimens from Graauweduinen, Vanrhynsdorp District coast, Cape Province, unless otherwise stated, coll. S. Haughton.

Non-type material. SAM-PQ-AV398, 18 specimens, 18–58 mm, Avontuur A, 50 m Complex. SAM-PQ-HB344, 28 specimens, 16–57 mm, Hondeklip Zone 12. SAM-PQ-HB334, 5 specimens, 81–110 mm, Hondeklip Zone 12. SAM-PQ-KN460, 2 specimens, 103 mm, 110 mm, Koingnaas, 50 m Complex.

Description

Shell thaidid-like, variable, with aperture longer than spire. Protoconch of 1–1½ whorls, apparently smooth (but all specimens apically somewhat eroded); 4+ postnatal whorls, generally with well-marked shoulder. Spire in relation to body whorl variable, squat in some specimens and half length of aperture, to

more slender and three-fourths length of aperture. Sculpture variable, squatter specimens generally with stronger sculpture; early whorls with 4 strong spiral bands and numerous axial lamellae between bands and upper and lower suture lines, giving cancellate appearance. Spiral bands increasing on to body whorl, with intermediaries appearing in some specimens; up to 20 major spiral bands, running on to base. Cancellation usually lost on body whorl. Specimens having weaker spiral sculpture usually with shoulder marked by single somewhat stronger band; sculpture in these specimens often becoming obsolete on body whorl. Columella smooth, concave in lower half. Base rounded, fasciole strong. Inner surface of outer lip generally plicate, folds becoming obsolete in larger specimens.

Remarks

Barnard (1962: 182) noted that *Nucella praecingulata* resembles both *Nucella cingulata* (Linnaeus, 1758) and *N. squamosa* (Lamarck, 1816), but reaches a much greater size than either of these living species.

Haughton (1932) quotes a note from Tomlin, in which the latter suggests the name 'praecingulata', and also observes the similarity to *N. cingulata* and *N. squamosa*. Haughton, while not presenting a formal description, noted the variability of the species, did not designate a holotype, but saw all the material listed above under 'Syntypes' (Fig. 17).

In spite of being highly variable, large specimens of *N. praecingulata* (approx. 100 mm) are easily identified, being the only whelk of such dimensions in the west-coast deposits. Smaller specimens, in the size range of *N. cingulata* and *N. squamosa*, however, are more difficult to assign.

In the majority of smaller specimens of *N. praecingulata* the body whorl and at least the two earlier whorls have a faint but distinct shoulder on the upper part of the whorl. The strength of the spiral bands varies. In those specimens in which the spiral bands are few and strong, the resemblance to *N. cingulata* is unmistakable, even to the possession of five axial lines between the spiral bands, leading to the squamose appearance sometimes seen in *N. cingulata*. In these specimens, the whorls tend to have an evenly rounded profile. In those specimens in which the spiral bands are finer and more numerous, the axial lines lead to a cancellate appearance very similar to *N. squamosa* (see Fig. 19). In these, the slightly angular whorl profile is more apparent, but even here, evenly rounded whorls are encountered.

It is suggested that with the change to a colder regime on the west coast during the Pleistocene, *Nucella praecingulata* gave rise to two forms, *Nucella cingulata* and *N. squamosa*, both being intertidal to shallow infratidal forms, neither attaining the dimensions of the ancestor, and with *N. cingulata* being confined to the colder waters of the west coast to False Bay, while *N. squamosa*, perhaps with greater temperature tolerance, extends to the Transkei coast.

Nucella praecingulata has not been recorded concurrently with *N. cingulata* or *N. squamosa*, a further indication of the form's possible ancestral role.





Fig. 17. *Nucella praecingulata*. A, B. Syntypes. Scale = 30 mm.

B

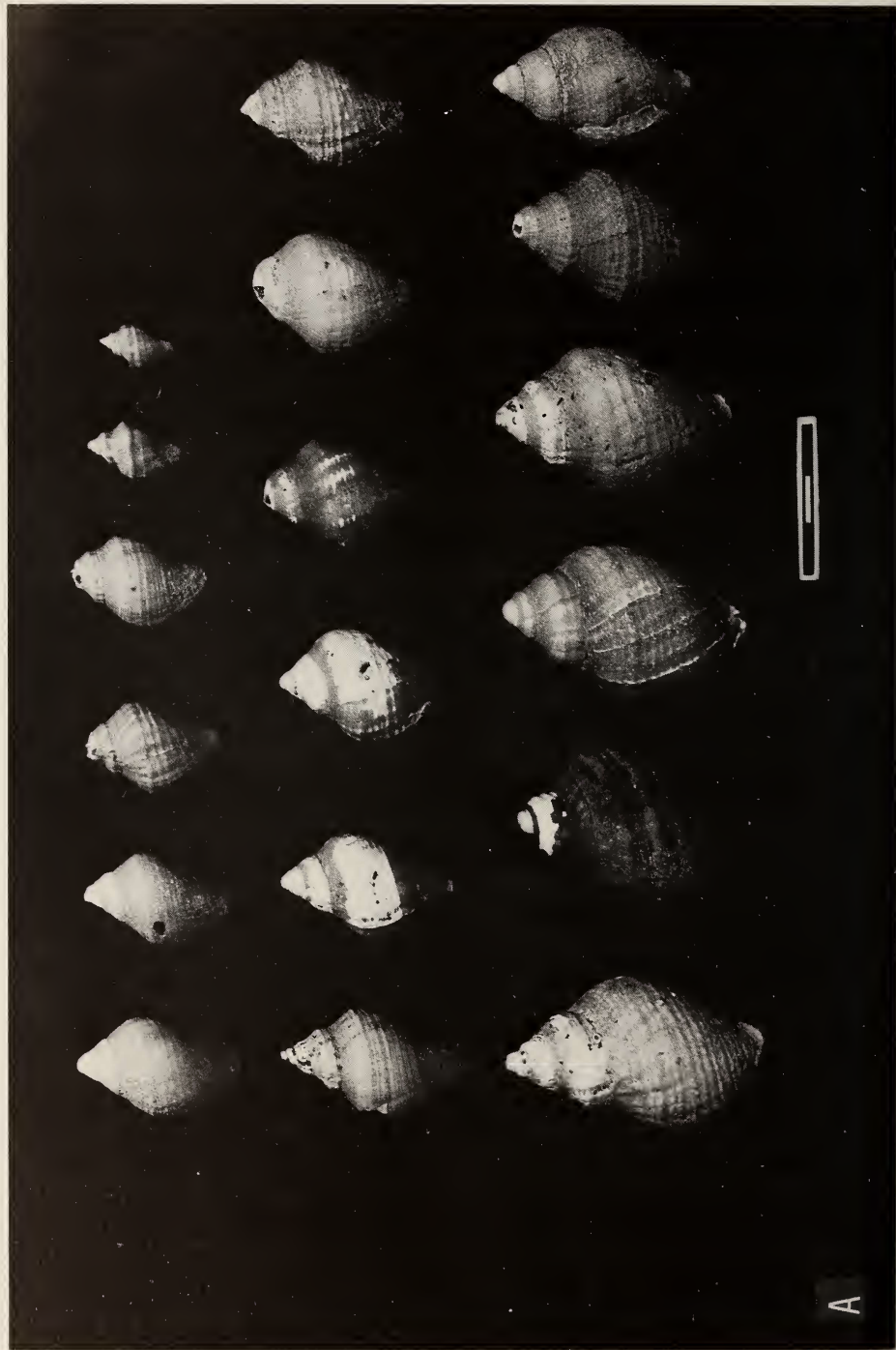




Fig. 18. *Nucella praecingulata*. A. Avontuür specimens. Scale = 30 mm. B. Hondeklip specimens. Note oyster shells on lower left specimen. Scale = 30 mm.

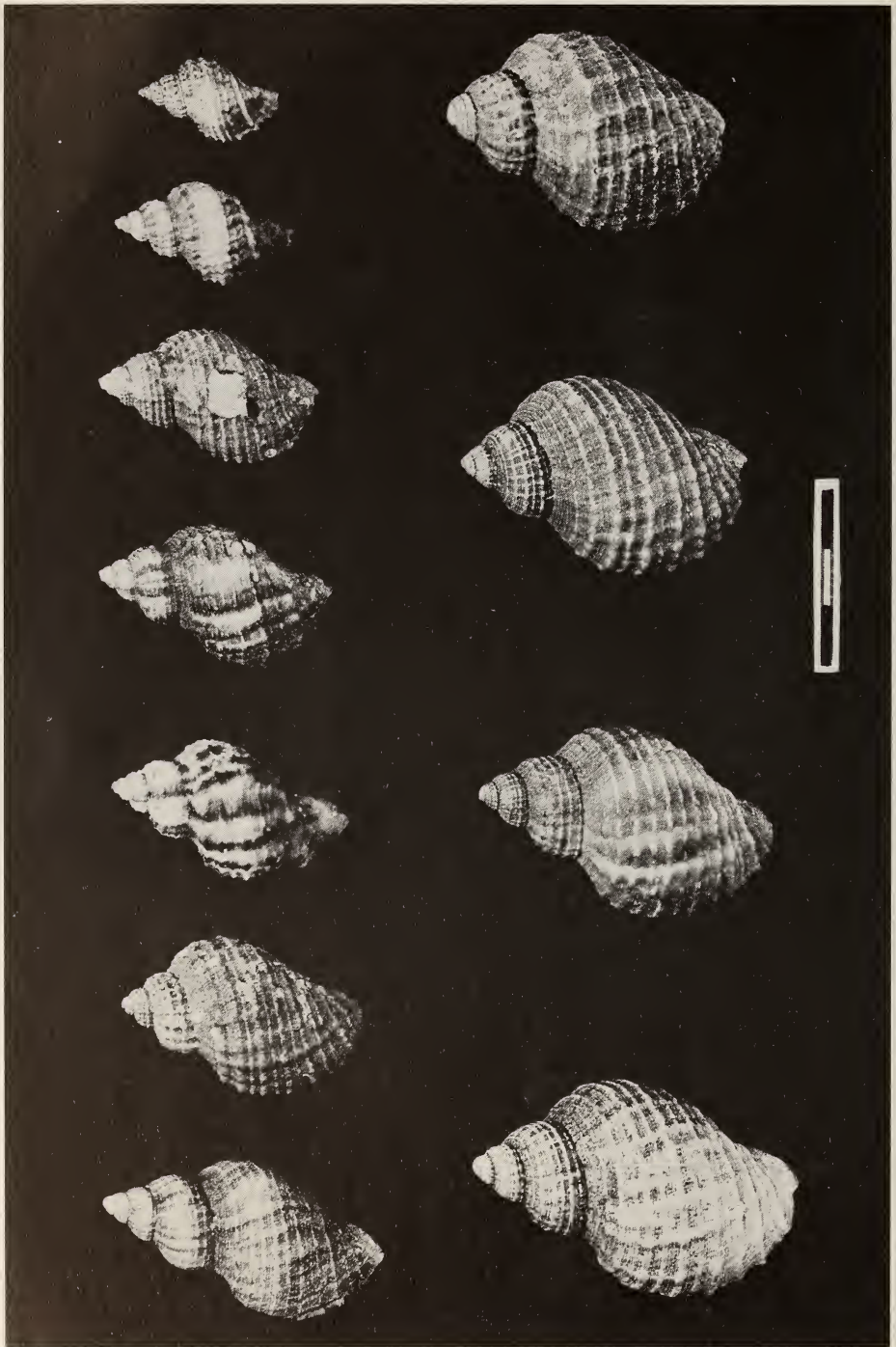


Fig. 19. *Nucella squamosa*. Recent specimens from Cape Peninsula and False Bay. Scale = 30 mm.

Thais arenae sp. nov.

Fig. 20

Material

Holotype. SAM-PQ-KN530, almost complete specimen, length 52,5 mm, greatest width 27,3 mm, Koingnaas KL south face.

Non-type material. SAM-PQ-KN307, 3 fragments (body whorls, somewhat worn), Koingnaas KL south face.

Description

Shell with at least 4 postnatal whorls; aperture longer than spire. (The holotype, an almost complete specimen, lacks the tip of the spire.) Whorls with distinct shoulder in upper half. Columella smooth; short anterior canal flexed slightly to left. Second extant whorl with 14 axial ribs, spiral sculpture worn away. Third whorl with 11-12 axial ribs, 2 strong spiral keels, upper forming shoulder; axial ribs rounded at intersections with strong keels; fine spiral sculpture over entire whorl, 11-12 lirae between suture and shoulder, 9-10 below shoulder.



Fig. 20. *Thais arenae*. Holotype. Scale = 10 mm.

Body whorl with 10 axial ribs, becoming obsolete on outer lip; 5 strong keel-like spiral bands; 12–13 fine lirae between suture and shoulder; 10–12 fine lirae between each strong spiral band; 4 fine lirae between lowest band and base.

Remarks

The present species bears some resemblance to *Thais capensis* (Petit, 1852), especially in the fine spiral lirae, but the latter is a relatively squatter species having somewhat stronger tubercles, especially on the body whorl. *Thais haemastoma* (Linnaeus, 1767), especially in the form occurring at present at the southern end of its West African range, has a much squatter shell bearing variable rounded tubercles on the shoulder, rather than the rounded ribs of *T. arenae*.

Lathyrus armatus A. Adams (see Nicklés 1950: 106) from the Azores, the Canary Islands, and Senegal, has a similar overall shape and sculpture. Although the holotype of *T. arenae* shows some wear on the axial ridges and tubercles, these are still more rounded than in the West African species. Also, the anterior canal is more defined in the latter species.

Etymology

The specific name, from the Latin, of a sandy place, refers to the coarse sands of the type-locality at Koingnaas KL south face.

Family Muricidae

Ocenebra bonaccorsii (Carrington & Kensley, 1969)

Tritonalia bonaccorsii Carrington & Kensley, 1969: 196, pl. 19.

Material

SAM-PQ-HB531, 39,1 × 22,0 mm, Hondeklip A Block, 30 m Complex. SAM-PQ-HB532, 2 specimens, 8,4 × 4,8 mm, 8,1 × 4,0 mm, Hondeklip Zone 12, 50 m Complex. SAM-PQ-HB152, 22,1 × 10,8 mm (protoconch missing), Hondeklip Zone 3.

Remarks

The PQ-HB531 specimen above is both larger and better preserved than the holotype. The description of the species can thus be supplemented:

Protoconch of 2–2½ whorls; 4½ postnatal whorls. First two postnatal whorls bicarinate; third whorl with upper carina stronger than lower; postnatal whorl 2 with 4 fine spiral lirae between suture and upper carina, 2–3 fine lirae between upper and lower carina; 2–3 lirae between lower carina and suture. Postnatal whorls 3 and 4 with 8–9 lirae between upper suture and upper carina; 4–5 lirae between carinae; 4 lirae between lower carina and lower suture. Body whorl with 13–15 lirae between upper suture and strongest spiral ridge; 8 strong spiral ridges, 9 fine lirae between uppermost strong ridge and next, number of fine lirae decreasing anteriorly to two or three between stronger ridges. Inner surface of outer lip with 8 rounded ridge-teeth.

Ocenebra petrocyon sp. nov.

Fig. 21

Material

Holotype. SAM-PQ-HB533, 9,9 × 4,8 mm, Hondeklip, 30 m Complex.

Paratypes. SAM-PQ-HB534, 10,6 × 5,7 mm, 8,6 × 4,6 mm; Hondeklip, 30 m Complex. SAM-PQ-HB535, 5 damaged specimens, 20 juvenile specimens; Hondeklip A Block, 30 m Complex.



Fig. 21. *Ocenebra petrocyon*. Holotype at left, remainder of specimens paratypes. Scale = 3 mm.

Description

Protoconch of $1\frac{1}{2}$ smooth whorls; 4 postnatal whorls. Aperture subequal to, or slightly longer than, spire. Sculpture consisting of rounded axial ribs and spiral lirae. Axial ribs: 11–12 on first whorl; 11–12 on second whorl; 11 on third whorl; 11 on body whorl. Spiral lirae: 4 on first whorl; 5 on second whorl; 5 on third whorl; 5 (with 1 or 2 very fine intermediates) on fourth whorl; 18–20 on body whorl (outer lip), including several finer intermediates; lirae running on to anterior canal. Lirae somewhat broadened at intersection with axial ribs, but never becoming bead-like. Narrow, smooth columella callus present. Inner surface of outer lip with 8–10 faint spiral ribs.

Remarks

Ocenebra petrocyon most closely resembles *O. purpuroides* (Reeve, 1845) (with which it was collected), especially in general shape and body-whorl sculpture. The new species differs from *O. purpuroides* in that the upper two or three whorls are not cancellate; in having more spiral lirae per whorl; in having spiral lirae evenly spaced between the upper and lower suture lines (*O. pur-*

puroides has a distinct shoulder and no lirae between shoulder and the upper suture line); and in having the axial ribs more rounded (almost carinate in *O. purpuroides*).

Etymology

The specific name is the Latinized form of the Greek for 'dog stone', and alludes to the farm Hondeklip.

Trophon carringtoni sp. nov.

Fig. 22

Latixis sp. Carrington & Kensley, 1969: 195, pl. 19.

Material

Holotype. SAM-PQ-AV536, 42,5 × 22,5 mm, Avontuur A, 50 m Complex.

Paratypes. SAM-PQ-AV537, 2 specimens, 37,1 × 22,4 mm, 40,8 ×

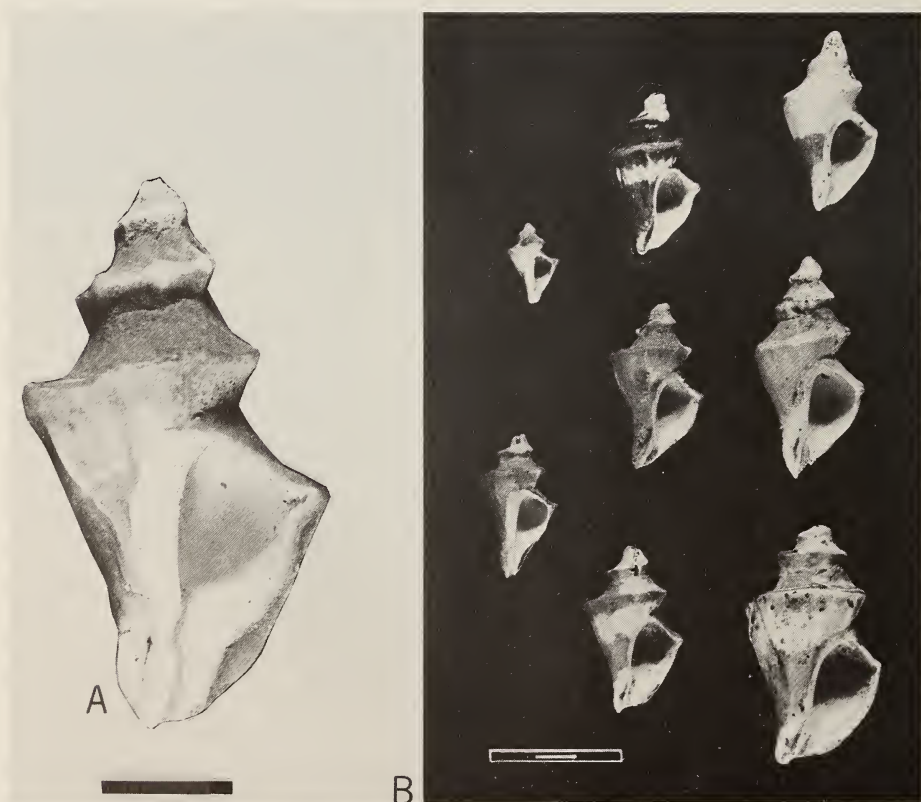


Fig. 22. *Trophon carringtoni*. A. Holotype. Scale = 10 mm. B. Range of paratypes. Scale = 30 mm.

24,5 mm, Avontuur A, 50 m Complex. SAM-K1447, 62,5 × 37,0 mm, outer lip missing, Strandfontein, 45–50 m Complex, coll. A. J. Carrington. SAM-PQ-AV538, 8 specimens (all with eroded apices), 58,0 × 32,0 mm, 53,0 × 28,0 mm, 42,5 × 23,5 mm, 40,2 × 24,0 mm, 40,0 × 23,5 mm, 38,2 × 22,0 mm, 34,8 × 20,0 mm, 20,0 × 13,0 mm, Avontuur A, 50 m Complex. USNM 400986, 3 specimens (all with eroded apices), 42,0 × 24,8 mm, 43,0 × 23,3 mm, 38,0 × 25,9 mm, Avontuur A, 50 m Complex.

Description

Shell of 4–5 postnatal whorls; aperture longer than spire. Whorls with single prominent keeled shoulder. Early whorls with irregular axial ridges, giving appearance of cancellate sculpture below keel, forming more or less well defined squamae where keel intersected. In later whorls, 6–8 axial ridges only faintly indicated above keel, stronger below keel, especially on body whorl, forming faint swelling at intersection with keel. Columella smooth, with callus developed. Inner surface of outer lip with 5 tubercles below carinal notch. Short anterior canal flexed to left.

Remarks

In the original mention of this species (Carrington & Kensley 1969: 195) the resemblance to *Latiaxis tortilis* (= *L. nakamigawai* io Kilburn, 1974) was mentioned. This comparison no longer stands, as the present species is more slender, does not have a strongly flexed anterior canal, and appears to lack spiral sculpture, other than the carina.

The general shape and sculpture are reminiscent of members of the Trophoninae, but resemble nothing recorded in the southern African fauna.

Etymology

The species is named for Mr A. J. Carrington of De Beers Consolidated Diamond Mines.

Family Buccinidae

Burnupena rogersi sp. nov.

Fig. 23

Material

Holotype. SAM-PQ-HB539, 58,1 × 34,5 mm (body whorl plus 2½ whorls, remainder of spire missing), Hondeklip Zone 3, 50 m Complex.

Paratypes. SAM-PQ-HB540, 14 specimens, 48,3 × 30,5 mm to 14,7 × 8,7 mm (larger specimens with outer lip and/or body whorl damaged and spire missing; smaller specimens complete). Hondeklip Zone 3, 50 m Complex. USNM 400987, 5 specimens, 38,4 × 24,3 mm to 15,7 × 8,9 mm, Hondeklip Zone 3, 50 m Complex.



Fig. 23. *Burnupena rogersi*. Holotype at upper left corner, remainder of specimens paratypes. Scale = 20 mm.

Description

Shell about 1,5 times longer than wide. Protoconch unknown; at least 5 postnatal whorls. Profile of earlier whorls evenly convex; of last 3 whorls with distinct, rounded shoulder. Sculpture of fine spiral bands separated by narrow incised grooves; 7–8 on third from last whorl, 14–15 on penultimate whorl, 35–42 on body whorl, extending on to outer surface of anterior canal, flattened bands becoming obscure, divided by shallow incised lines on lower body whorl. No axial sculpture apart from faint growth lines, and several aperture margin ridges in larger specimens. Narrow gutter formed at suture line on last whorl, becoming closed on earlier whorls. Inner surface of outer lip with about 10 faint ridges. Base narrowly umbilicate; columella lacking pleats; with weak callus; anterior canal short, flexed slightly to left.

Remarks

The present material, showing a strongly sunken suture, bears some resemblance to the genus *Babylonia*. *Burnupena rogersi*, however, is plumper than the two South African species of *Babylonia*, neither of which possesses fine spiral sculpture.

While the generic position of the present material cannot be established in the absence of radula, soft parts, and operculum, the species does bear a general resemblance to species of *Burnupena*, and especially to *B. papyracea* (Bruguière, 1789), which sometimes does show a fairly sunken suture.

Etymology

The species is named for Dr John Rogers of the Department of Geology, University of Cape Town.

Burnupena aestus sp. nov.

Figs 24, 25

Material

Holotype. SAM-PQ-AV541, 69,9 × 31,0 mm, Avontuur A, 50 m Complex.

Paratypes. SAM-PQ-AV542, 3 specimens, 62,4 × 30,3 mm (apex and outer lip damaged), 67,1 × 29,9 mm, 68,4 × 32,0 mm, Avontuur A, 50 m Complex. SAM-PQ-HB543, 76,6 × 29,7 mm (apex damaged), Hondeklip Zone 12, 50 m Complex. SAM-K1445, 61,3 × 27,0 mm (body whorl damaged), Swartlintjies, coll. A. J. Carrington, 1967. SAM-K1446, 67,1 × 34,6 mm (body whorl damaged), Swartlintjies, coll. A. J. Carrington, 1967.

Description

Shell elongate, relatively slender, spire longer than aperture. At least 5 postnatal whorls. Profile of whorls convex, with slight hollowing just below suture. Columella smooth, basally flexed slightly to left, with rounded ridge just

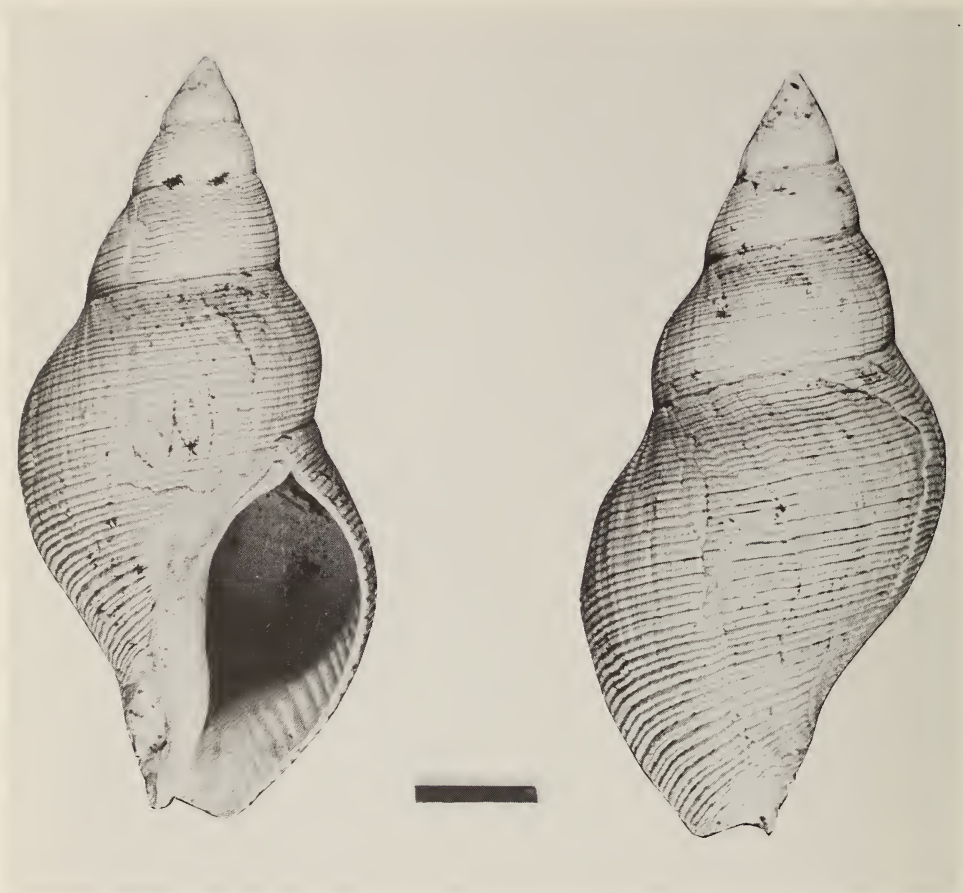


Fig. 24. *Burnupena aestus*. Holotype. Scale = 10 mm.

below suture; base rounded. Inner surface of outer lip with 20–22 rounded ridges. Sculpture consisting of fine spiral lirae, occasionally doubled on lower whorls; spiral lirae narrowly rounded to carinate. Second whorl with 10–12 lirae; third with 12–15; fourth with about 20; body whorl with up to 56 lirae.

Remarks

In general proportions, the present species most resembles *Afrocominella capensis* (Dunker, 1844), but lacks the obscure axial sculpture of the early whorls typical of this species. The spiral lines are finer and more numerous than in *A. capensis*, while the aperture is generally subequal in length to the spire. The present species attains a much larger size than either *A. capensis* or *Burnupena papyracea*, the other species to which it bears some similarity. This latter species is much squatter, with fewer spiral lines.



Fig. 25. *Burnupena aestus*. Paratypes. Scale = 20 mm.

There is a possibility of confusing small specimens of this species with large specimens of *Triumphis dilemma* (see below). The two species may, however, be easily separated on the following features: columella smooth in *B. aestus*, with 2–4 tubercles in *T. dilemma*; aperture longer than spire in *T. dilemma*, shorter than spire in *B. aestus*; outer lip frequently thickened in *T. dilemma*, unthickened in *B. aestus*; spiral cords on body whorl and anterior canal often doubled,

normally rounded to carinate in *B. aestus*, spiral cords single, rounded to tabulate in *T. dilemma*.

Etymology

The specific name is derived from the Latin 'aestus', of the surf, and refers to the probable habitat of the species.

Triumphis dilemma Kilburn & Tankard, 1975

Fig. 26

Triumphis dilemma Kilburn & Tankard, 1975: 200, fig. 10.

Material

Holotype. SAM-K4565, 16,3 × 10,4 mm, Langebaan, Early Pleistocene, coll. A. J. Tankard.

Non-type material. SAM-PQ-HB544, 10 specimens, 27,2 × 17,8 mm to 39,1 × 22,0 mm, Hondeklip Zone 4A, 50 m Complex. SAM-PQ-AV545, 6 specimens, 25,3 × 15,0 mm to 33,0 × 19,9 mm, Avontuur A, 50 m Complex. SAM-K4862, 4 specimens (2 damaged), 24,9 × 13,2 mm, 30,9 × 16,3 mm, Somnaas SN4, Hondeklip Bay, coll. A. J. Tankard.

Previous records

Early Pleistocene, Langebaan, 9,5 m beach.

Remarks

With a wider range of material available, the original description can be supplemented: parietal area with single tooth in most cases; 2 teeth (as in holotype) only very occasionally seen. Outer lip only occasionally not thickened; with 10–17 internal ridges. Columella with 2–5 basal tubercles, 2 most common. Spiral cords rounded to tabulate. Aperture longer than spire, generally not as constricted as in holotype. Kilburn & Tankard (1975) mentioned two damaged specimens considerably larger than the holotype, about which they had reservations. With good material in this size range, it can be seen that the two earlier specimens are in fact this species, and that the higher counts of spiral cords are typical of the species.

Family Nassariidae

Bullia annulata (Lamarck, 1816)

Bullia annulata: Barnard, 1959: 127, figs 25f, 27e; 1962: 189.

Bullia magna Haughton, 1932: 46, pl. 5 (figs 1, 4, 5). Barnard, 1959: 129; 1962: 182, 189.

Material

SAM-9897 (syntypes of *B. magna*), 2 incomplete specimens, Graauwe-duinen, Vanrhynsdorp District coast, Cape Province. SAM-7998, (syntypes of *B. magna*), 16 incomplete specimens, Doornbaai, south of Olifants River mouth,



Fig. 26. *Triumphis dilemma*. Range of material from Hondeklip, 50 m Complex. Scale = 30 mm.

Cape Province. SAM-K4863, 1 specimen, 67,6 × 32,2 mm, Swartlintjies SL2, Hondeklip Bay, coll. A. J. Tankard. SAM-PQ-HB210, 3 specimens, 63,7 × 30,1 mm, 68,7 × 32,2 mm, 55,6 × ? mm (body whorl incomplete), Hondeklip Zone 12, 50 m Complex. SAM-PQ-AV233, 7 specimens (3 incomplete), 64,3 × 30,7 mm, 60,8 × 30,8 mm, 59,9 × 30,3 mm, 51,2 × 26,9 mm, Avontuur, 50 m Complex. SAM-PQ-AV588, 12 specimens, Avontuur, 50 m Complex. SAM-PQ-HB613, 1 specimen, Hondeklip Zone 4A, 50 m Complex. SAM-PQ-HB889, 2 specimens, Hondeklip Zone 12, 50 m Complex.

Remarks

Barnard (1962) expressed the view that *Bullia magna* was merely a worn and fossilized *B. annulata*. All the syntypic material is extremely worn, only one specimen showing faint spiral sculpture.

The present material, while friable, shows good preservation of detail, and possesses the distinctive spiral lirae characteristic of *B. annulata*.

While only one of the specimens from the 50 m Complex shows the development of a shoulder on the upper whorl, approaching the condition in typical *B. annulata*, Barnard (1962) does note that some recent specimens show only a weak development of the shoulder. The present material removes any doubt that *B. magna* really is *B. annulata*.

The Hondeklip specimens occurred in a very fine sand, in a layer dominated by specimens of the bivalve *Dosinia sicarisinus* sp. nov., often with both valves in life position.

Distribution

Living *B. annulata* occurs from Saldanha Bay to Mozambique, from the low-tide mark, but more usually infratidally, to 100 m (Barnard 1958; Kilburn & Rippey 1982).

Fossil *B. annulata* has been recorded from Langebaan, Milnerton, Swartkops, Redhouse and Coega (Barnard 1959, 1962).

Nassarius cf. kochianus (Dunker, 1846)

Nassarius kochianus (Dunker), Kilburn & Rippey, 1982: 100, 213, pl. 23 (fig. 8).
Nassa kochiana: Barnard, 1959: 104, figs 22b, 23b; 1962: 189.

Material

SAM-PQ-KN546, 3 specimens, 10,9 × 6,1 mm, 9,1 × 5,1 mm, 7,6 × 4,1 mm, Koingnaas KL south face.

Previous records

Living: False Bay to Transkei, intertidal to shallow infratidal.

Fossil: Algoa Bay.

Remarks

With slightly fewer axial ribs (13–14 per whorl) than is usual for *N. kochianus* (15–18), the present material, however, does have only a single columella nodule, and in profile more closely resembles this species than it does *N. signatus* (Dunker, 1847). More specimens are needed to decide the range of variation in the number of axial ribs, before a more definite identification can be attempted.

Family Fascioliariidae

Fasciolaria dinglei sp. nov.

Figs 27, 28

Fasciolaria sp. Carrington & Kensley, 1969: 193, pl. 18 (?partim).*Material*

Holotype. SAM-PQ-AV547, 101 × 41 mm (apex and upper whorls eroded), Avontuur A, 50 m Complex.

Paratypes. SAM-PQ-AV548, 3 body whorl fragments, 7 specimens, 39,4 × 19,8 mm to 83,4 × 40,3 mm, Avontuur A, 50 m Complex.

Description

Shell with aperture longer than spire. Four to five postnatal whorls. Profile of whorls evenly convex. Third whorl with 12–13 fine spiral lirae; fourth with 15–16 lirae; body whorl with 50–55 lirae running on to anterior canal; lirae on upper



Fig. 27. *Fasciolaria dinglei*. Holotype. Scale = 10 mm.

body whorl near suture having finer intermediates appearing; lirae on base of body whorl becoming coarser and broader. Columella with 3 pleats, sometimes obscured in large specimens; low ridge on upper columella just below suture. Anterior canal about half length of rest of aperture, flexed to left. Inner surface of outer lip with up to 25 rounded ridges.

Remarks

Of the two specimens of *Fasciolaria* figured by Carrington & Kensley (1969, pl. 18c), the smaller may well be the present species. The larger, however, is undoubtedly a large *Burnupena*, lacking as it does an elongate anterior canal.

Carrington & Kensley (1969) noted the similarity of their specimen to *Fasciolaria lugubris* (Reeve, 1847). This similarity in overall proportions and general sculpture is again noted, but several differences easily separate the two species. The most distinctive feature of the new species is the presence of three pleats on the columella (*F. lugubris* is unpleated). The spiral sculpture of *F. dinglei* is much finer and the lines more numerous (up to 55 on the body whorl) than in *F. lugubris* (up to 30 on body whorl, and more raised).



Fig. 28. *Fasciolaria dinglei*. A. Range of paratypes. Scale = 10 mm. B. Range of paratypes. Scale = 30 mm.

Etymology

The species is named for Professor Richard V. Dingle, Department of Geology, University of Cape Town.

Family *Olividae**Melapium hawthornei* sp. nov.

Fig. 29

Material

Holotype. SAM-PQ-KN549, 27,5 × 24,0 mm, Koingnaas KN-1.

Paratypes. SAM-PQ-KN550, 12 specimens, 23,4 × 16,7 mm to 26,1 × 20,1 mm, Koingnaas KN-1, 50 m Complex. USNM 400988, 4 specimens, 23,4 × 17,1 mm to 27,0 × 18,9 mm, Koingnaas KN-1, 50 m Complex.

Non-type material. SAM-PQ-KN551, 9 specimens, all worn and damaged, Koingnaas KL south face. SAM-PQ-KN366, 16 specimens, all damaged, Koingnaas KN-1, 50 m Complex.

Description

Shell 1,2 times longer than wide, of 4 postnatal whorls. Spire somewhat sunken, but still protruding. Body whorl globose, profile evenly convex, with very faint, shallow, spiral lines, and irregular axial growth lines. Parietal callus extending from body-whorl suture in evenly convex line to lower columella. Posterior canal short, but with distinct notch; anterior canal flexed to left; lower columella narrowed, with fasciole strong but barely visible in apertural view; outer lip evenly convex to notch at anterior canal.

Remarks

Two living and one fossil species of *Melapium* have been recorded from southern Africa, all of which differ from the present species.

Melapium lineatum (Lamarck, 1822), known from Still Bay to Zululand in depths of 30–160 m, is of comparable size to *M. hawthornei*, but possesses a more elevated spire; also, the lower columella is broader, with the fasciole being strong and visible in apertural view. *Melapium lineatum* also has a distinct concavity just above the fasciole origin, and below the bulge of the body whorl; *M. hawthornei*, by contrast, is evenly convex in this region.

Melapium elatum (Schubert & Wagner, 1829), from deeper water off Natal and Mozambique, has a much larger shell, with the lower columella very broad and with a very strong fasciole, and a distinct shoulder on the upper body whorl.

Melapium patersonae Bullen Newton, 1913, from the Neogene of Bredasdorp to Alexandria, Cape Province, is also a large shell, up to 70 mm in length, has a sunken spire, a well-developed posterior canal with the outer lip reaching posteriorly above the spire, and a very broad columella with a very strong carinate fasciole.



Fig. 29. *Melapium hawthornei*. Holotype at upper left corner, remainder of specimens paratypes. Scale = 20 mm.

Etymology

The species is named for Mr J. B. Hawthorne of De Beers Consolidated Diamond Mines.

Pseudoliva lutulenta sp. nov.

Fig. 30

Material

Holotype. SAM-PQ-KN552, 31,6 × 22,7 mm, Koingnaas KN-1.

Paratypes. SAM-PQ-KN553, 8 complete specimens, 20,7 × 15,8 mm to 29,2 × 21,2 mm, Koingnaas KN-1. USNM 400989, 3 complete specimens, 23,1 × 18,1 mm to 28,3 × 21,5 mm, Koingnaas KN-1.

Non-type material. SAM-PQ-KN373, 13 specimens (damaged), Koingnaas KN-1.

Description

Shell globose, thick-walled, longer than wide, of 4 whorls. Spire short. Whorl profiles evenly convex; suture somewhat incised. Columella callus smooth, convex, reaching posteriorly to level of suture, outline evenly convex on inner-lip body whorl; parietal node somewhat elongate, forming shallow groove-like posterior canal. Base with strong furrow running from shallow sinus in anterior outer lip, around lower body whorl, to midpoint of columella callus; second, less clearly defined groove anterior to strong groove, neither groove marked on inner surface of outer lip.

Remarks

Three major differences separate the present material from the apparently very similar living *Pseudoliva crassa* (Gmelin), known only from Angola, and figured and described as *P. plumbea* (Chemnitz) by Nicklés (1950: 107, fig. 189). The living species possesses two strong well-defined grooves on the anterior body whorl, the upper of which is marked by a narrow 'excroissance' on the internal surface of the outer lip. In the present species there is one strong groove and a far less well-defined more anterior groove. Neither groove is reflected by any structure on the internal surface of the outer lip. The columella callus in *P. crassa* is concave, and posteriorly narrowed to the posterior canal. In *P. lutulenta* the columella callus is convex, and posteriorly broadly rounded.

Böhm (1926) described two species of *Pseudoliva* from the Cretaceous of Bogenfels, South West Africa-Namibia, neither of which bears much resemblance to the present species. *Pseudoliva thielei* Böhm shows enormous columella callus development, and has several spiral ridges on the shell base; *P. leutweini* Böhm is a much larger species than *P. lutulenta*, with a massive upper columella callus.



Fig. 30. *Pseudoliva lutulenta*. Holotype at upper left corner, remainder of specimens paratypes. Scale = 20 mm.

Etymology

The specific name is derived from the Latin 'lutulentus', covered with mud, and alludes to the fine sediments in which the species was found.

Family Turridae

Drillia tempestae sp. nov.

Fig. 31

Material

Holotype. SAM-PQ-HB554, 12,1 × 5,1 mm, Hondeklip Zone 3, 50 m Complex.

Paratypes. SAM-PQ-HB555, 10 specimens, 6,3 × 3,4 mm to 19,4 × 7,7 mm, Hondeklip Zone 3, 50 m Complex. USNM 400990, 10 specimens, 6,3 × 2,0 mm to 16,4 × 7,2 mm, Hondeklip Zone 3, 50 m Complex.

Non-type material. SAM-PQ-SL260, 1 specimen, 19,9 × 8,4 mm, Swart-lintjies River, spoil heap. SAM-PQ-HB556, approx. 50 specimens, Hondeklip Zone 3, 50 m Complex.

Description

Protoconch of 1½ smooth whorls; 6½–7 postnatal whorls. Spire 1,3–1,5 times length of aperture. Sculpture consisting of rounded axial ribs and fine spiral lirae; axial ribs slightly oblique, occasionally perpendicular, rounded, with distinct shoulder well below upper suture line, reaching lower suture. Postnatal whorl 3 with 9 axial ribs, 6–9 spiral lirae; ribs increasing to 11 on body whorl, lirae to 10–18 on penultimate whorl; outer lip with 20–24 spiral lirae running on to outer surface of siphonal canal. Lirae equal in width on spire, becoming broader on body whorl and siphonal canal. Anal sinus in outer lip shallow. Columella callus smooth; anterior siphonal canal short, well marked.

Remarks

The present species resembles *Drillia caffra* (Smith, 1882) in overall proportions, but differs in details. The earlier species has more axial ribs per whorl (11–12 on early whorls, 15–18 on later whorls), more spiral lirae (6 on early whorls, up to 30 on last whorl), and possesses a deep anal sinus.

As generic placement in the Turridae is so dependent on radula structure, the present material is placed in *Drillia* purely because of an overall resemblance to some species in that genus.

Etymology

The specific name, from the Latin for 'of a storm', alludes to the storm conditions that probably caused some of the Hondeklip fossil accumulations.

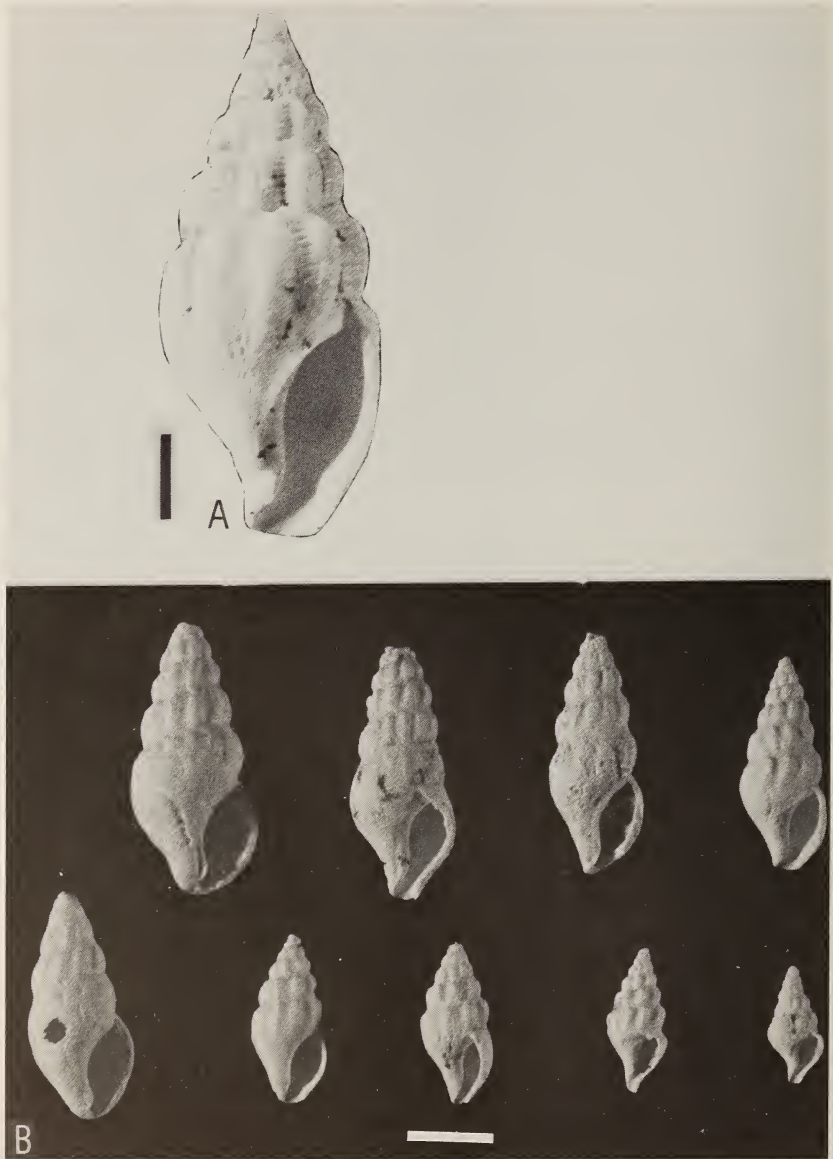


Fig. 31. *Drillia tempestae*. A. Holotype. Scale = 2 mm. B. Range of paratypes. Scale = 5 mm.

Family Terebridae

Terebra canisaxi sp. nov.

Fig. 32

Material

Holotype. SAM-PQ-HB557, 21,4 × 6,5 mm, Hondeklip Zone 12, 50 m Complex.

Paratypes. SAM-PQ-HB558, 10 specimens, 15,2 × 4,9 mm to 23,1 × 6,9 mm, Hondeklip Zone 12, 50 m Complex. USNM 400991, 10 specimens, 15,7 × 5,6 mm to 23,1 × 6,4 mm, Hondeklip Zone 12, 50 m Complex.



Fig. 32. *Terebra canisaxi*. Holotype at upper left corner, remainder of specimens paratypes. Scale = 10 mm.

Non-type material. SAM-PQ-HB559, 4 specimens, 14,6 × 4,9 mm to 17,7 × 5,7 mm, many fragments, Hondeklip Zone 12, 50 m Complex. SAM-PQ-HB331, 30 specimens, Hondeklip Zone 12, 50 m Complex.

Description

Shell of protoconch of 2½ smooth whorls, plus 7 postnatal whorls. Postnatal whorl sculpture consisting of strong, rounded, axial ribs running from upper to lower suture, sometimes alternating from one whorl to next, sometimes continuous. Postnatal whorl 1 with 9 ribs, following 6 whorls each with 8–9 ribs, body whorl with 9–10 ribs. Anterior canal short, open, flexed to left. Base rounded. Columella lacking pleats, smooth; low fasciole present. Spiral groove absent.

Remarks

This species closely resembles *Terebra lightfooti* Smith, 1903, recorded alive from Saldanha Bay to the Agulhas Bank to a depth of 62 m. Barnard (1969: 596) described this species as having eight postnatal whorls. *Terebra lightfooti* is a marginally more slender species than *T. canisaxi*, with slightly more numerous axial ribs (11–12 on last three whorls, as against 8–9 in *T. canisaxi*).

Etymology

The specific name is the Latinized form of 'dog stone', a direct translation of the name of the type-locality, Hondeklip.

Class BIVALVIA

Family Glycymeridae

Glycymeris fulleri sp. nov.

Figs 33, 34

Material

Holotype. SAM-PQ-SL561, both valves, 58,0 × 61,5 mm, Swartlintjies SL-20, 50 m Complex.

Paratypes. SAM-PQ-SL562, both valves, 38,0 × 40,5 mm, Swartlintjies SL-20, 50 m Complex. SAM-PQ-KN560, right valve, 40,2 × 44,1 mm, Koingnaas KN-1, 50 m Complex. SAM-PQ-KN563, 3 left valves, 25,0 × 26,8 mm, 36,2 × 40,0 mm, 46,3 × 46,0 mm (distorted), 1 right valve, 37,1 × ? mm, Koingnaas KN-1, 50 m Complex. USNM 400992, 2 left valves, 23,6 × 24,9 mm, 42,9 × ? mm, 1 right valve, 34,8 × ? mm, Koingnaas KN-1, 50 m Complex.

Description

All material in poor condition, with external surfaces exfoliating, and shape frequently deformed. Shell slightly inequilateral, posterior margin slightly more pointed than anterior margin; slightly wider than high. Sculpture of about 40 radiating, apparently flattened ribs, becoming obsolete in anterior and

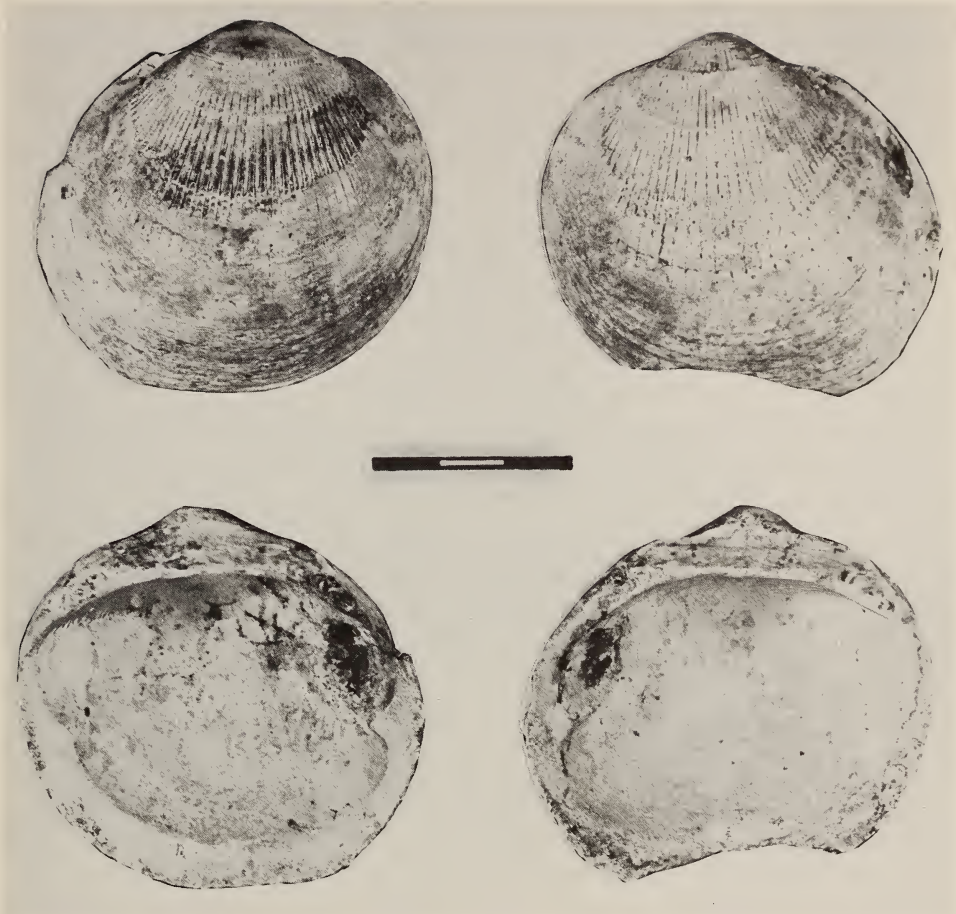


Fig. 33. *Glycymeris fulleri*. Holotype, external and internal views of both valves.
Scale = 30 mm.

posterior part of shell. Ventral margin faintly crenulate in external view, internally more strongly crenulate. Anterior and posterior adductor muscle scars situated on faint ledge. Hinge area with teeth discontinuous below umbo, divided into two groups, each of 7–9 teeth.

Remarks

Glycymeris fulleri resembles the living southern African east-coast species *G. queketti* (Sowerby, 1897) in having the muscle scars situated on faint ledges, but is a smaller and more inequilateral species. Barnard (1962: 183) mentions two specimens referred to *G. queketti* from Skulpfontein Point, Hondeklipbaai area, by Krige (1927), but questioned the identification.



Fig. 34. *Glycymeris fulleri*. Range of paratypes. Scale = 20 mm.

Glycymeris connollyi Tomlin, 1923, known living from Table Bay to Natal, is smaller than the present species, and more trigonal in outline.

Glycymeris borgesii (Cox, 1946) (= *G. africana* Cox, 1939), known from the Neogene of Ysterplaat, Cape Province (Tankard 1975a) as well as from the Alexandria Formation in the Port Elizabeth area, is a much larger species (up to 100 mm diameter), with the hinge teeth in a continuous band.

Glycymeris ovata (Broderip), recorded from the Pliocene and Pleistocene of Chile by Herm (1969) also shows the tooth row of the hinge divided into two parts, but this species is less markedly inequilateral and somewhat more trigonal than the present species.

Etymology

The species is named for Professor A. O. Fuller, Department of Geology, University of Cape Town.

Family Ostreidae
Ostrea cf. subradiosa Böhm

Fig. 35

Ostrea digitilina, non Dubois, Böhm & Weisfermel, 1913: 61, fig. 1a, pl. 8 (fig. 2).
Ostrea subradiosa Böhm, 1926: 56, text table A (figs 1-3).

Material

SAM-PQ-AV571, one left valve, 93 × 83 mm, Avontuur A, 50 m Complex.



Fig. 35. *Ostrea cf. subradiosa*. External and internal view of left valve. Scale = 10 mm.

Remarks

The present specimen has been compared with material in the South African Museum (SAM-K4936) from Bogenfels, as well as with the original descriptions and figures. Neither of the figures of Böhm & Weisfermel (1913) shows a row of pits in the shell margin close to the hinge area. The figure of Böhm (1926), however, shows such a row of pits. The present specimen, while having the strong radiating external ribs seen in *O. subradiosa*, lacks these marginal pits. A more definite identification on the basis of a single specimen is not possible.

Family *Isognomonidae**Isognomon gariesensis* sp. nov.

Fig. 36A

Material

Holotype. SAM-PQ-HB564, incomplete right valve, upper (dorsal) part of valve missing, greatest length 158 mm, greatest width (across hinge area) 90,9 mm, Hondeklip A Block, 50 m Complex.

Paratypes. SAM-PQ-HB263, 1 incomplete left valve, Hondeklip A Block, 50 m Complex. SAM-PQ-KN565, 2 incomplete left valves (one 145 mm in length), Koingnaas KL south face.

Non-type material. SAM-PQ-KN368, numerous friable fragments, Koingnaas KN-1.

Description

Shell very thick (up to 40 mm on ventral margin), becoming thinner posterodorsally. Hinge with 11 elongate ligamental grooves; hinge width 36,5 mm.

Remarks

The genus *Isognomon* is largely a warm-water form. On the west African coast, living *Isognomon* occurs as far south as the Congo (Nicklés 1950: 172). On the east African coast, *I. anomioides* (Reeve, 1858) commonly occurs in rock pools as far south as the Transkei coast. *Isognomon perna* occurs occasionally in Natal. Both these latter species reach a total length of about 66 mm and are thin-shelled.

Isognomon cf. *gaudichaudi* (d'Orbigny, 1842) (from the Miocene of Chile) was recorded from Needs Camp, Cape Province (Woods 1908; Newton 1913) and originally was thought to be of Cretaceous age, but later was referred to the Cenozoic. The species has also been recorded from Redhouse, Koega, and Bushmans River, Cape Province. The specimens examined in the South African Museum are from Redhouse and Swartkops (Fig. 36B). Newton (1913) compared the Cape Province specimens with *I. maxillata* (Lamarck, 1801) from Europe, *I. conradi* (d'Orbigny, 1842) from Virginia, U.S.A., and *I. gaudichaudi* (d'Orbigny) from Chile, and on the basis of the hinge similarities decided that the South African specimens most closely resembled the South American species.

The present west-coast material is similar to the material from the Eastern Province in hinge structure, but is much thicker and heavier. The ventral marginal sinuosity of the *Isognomon* cf. *gaudichaudi* is more marked than in the Hondeklip material. While it is unlikely that either the present samples or the Eastern Province material is conspecific with the Chilean species, there is precedent for this distribution pattern. Kensley & Penrith (1970) recorded three species of mytilid bivalve molluscs, and one brachiopod species from northern South West



Fig. 36. A. *Isognomon gariesensis*. Holotype. B. *Isognomon* 'gaudichaudi'. Three specimens from Redhouse, Cape Province. Scales = 10 mm.

Africa–Namibia and Angola that occur in Pacific South America, while Kensley (1985*b*) recorded the South American thaidid *Concholepas* as a fossil from the west coast of South Africa. Until more complete material is available, it is wiser to give the present material new specific status, rather than confuse it with earlier-described species.

Etymology

The specific name is derived from Garies, the district in which the Hondeklip and Koingnaas localities are found.

Family **Carditidae**

Cardita unica sp. nov.

Fig. 37

Material

Holotype. SAM–PQ–KN566, 1 right valve, 44,0 × 67,5 mm, Koingnaas KL south face.

Description

Shell robust, thick, oblong, anterior margin rounded, ventral margin flattened, posterior margin more pointed than anterior. External sculpture consisting of 27 radiating ribs, becoming broadly flattened near ventral margin, separated by narrow grooves; ribs on posterior part of shell narrower than on rest of shell. Concentric growth lines irregular, wavy. Lower anterior and posterior margin and ventral margin on shell interior crenulate, crenulations largest at posteroventral corner. Anterior adductor scar oval; small circular hollow dorsal to anterior muscle scar, hidden under anterior hinge line. Posterior adductor scar anteriorly truncate, posteriorly rounded. Hinge line broad, solid; anterior lateral tooth almost vertical, short, separated from anterior cardinal tooth by triangular pit; anterior cardinal tooth acutely triangular with posterior margin twice length of anterior margin, separated from posterior cardinal tooth by narrowly triangular oblique groove; posterior cardinal tooth elongate, with horizontal dorsal part and oblique ventral part. Ventral margin of hinge area sinuous.

Remarks

The present specimen bears no resemblance to any carditid, fossil or living, recorded from southern or west Africa.

Etymology

The specific name, derived from the Latin 'unicus', meaning unique, refers to the fact that only a single valve of this species has been found, and that it bears no resemblance to any African carditid.



Fig. 37. *Cardita unica*. Holotype, external and internal view of right valve. Scale = 10 mm.

Cuna aquaedulcensis Kensley, 1977

Fig. 38

Cuna aquaedulcensis Kensley, 1977: 203, fig. 15.

Material

SAM-PQ-HB567, about 50 valves, largest specimen 7,5 × 7,1 mm, Hondeklip, 30 m Complex.

Description

Right valve, hinge with elongate anterior cardinal tooth, median tooth narrowly triangular, separated from anterior tooth by narrow triangular gutter.



Fig. 38. *Cuna aquaedulcensis*. Hinge details of left (upper) and right (lower) valves.

Posterior cardinal tooth reduced to short low rounded ridge. Left valve, hinge with elongate rounded ridge on anterior margin, running from anterior adductor muscle scar to umbo; 2 median teeth, anteriormost larger, smaller tooth narrow and lower; posterior tooth separated from margin by relatively deep groove.

Previous records

Quartzose Sand Member, Langebaanweg, Pliocene.

Remarks

As only two right valves were available when the species was described, it was thought useful to supplement the description, now that far more material is available.

Family **Veneridae**

Dosinia (Dosinia) sicarisinus sp. nov.

Figs 39, 40

Material

Holotype. SAM-K4877, both valves, 75,7 × 72,4 mm, thickness of two valves together 27,1 mm, Somnaas SN4, Hondeklip, 50 m Complex, coll. A. J. Tankard.

Paratypes. SAM-PQ-HB568, 4 left valves, 66,7 × 65,5 mm, 63,1 × 65,0 mm, 57,4 × 57,7 mm, ? × 66,9 mm, 1 right valve, 67,4 × 70,7 mm, Hondeklip

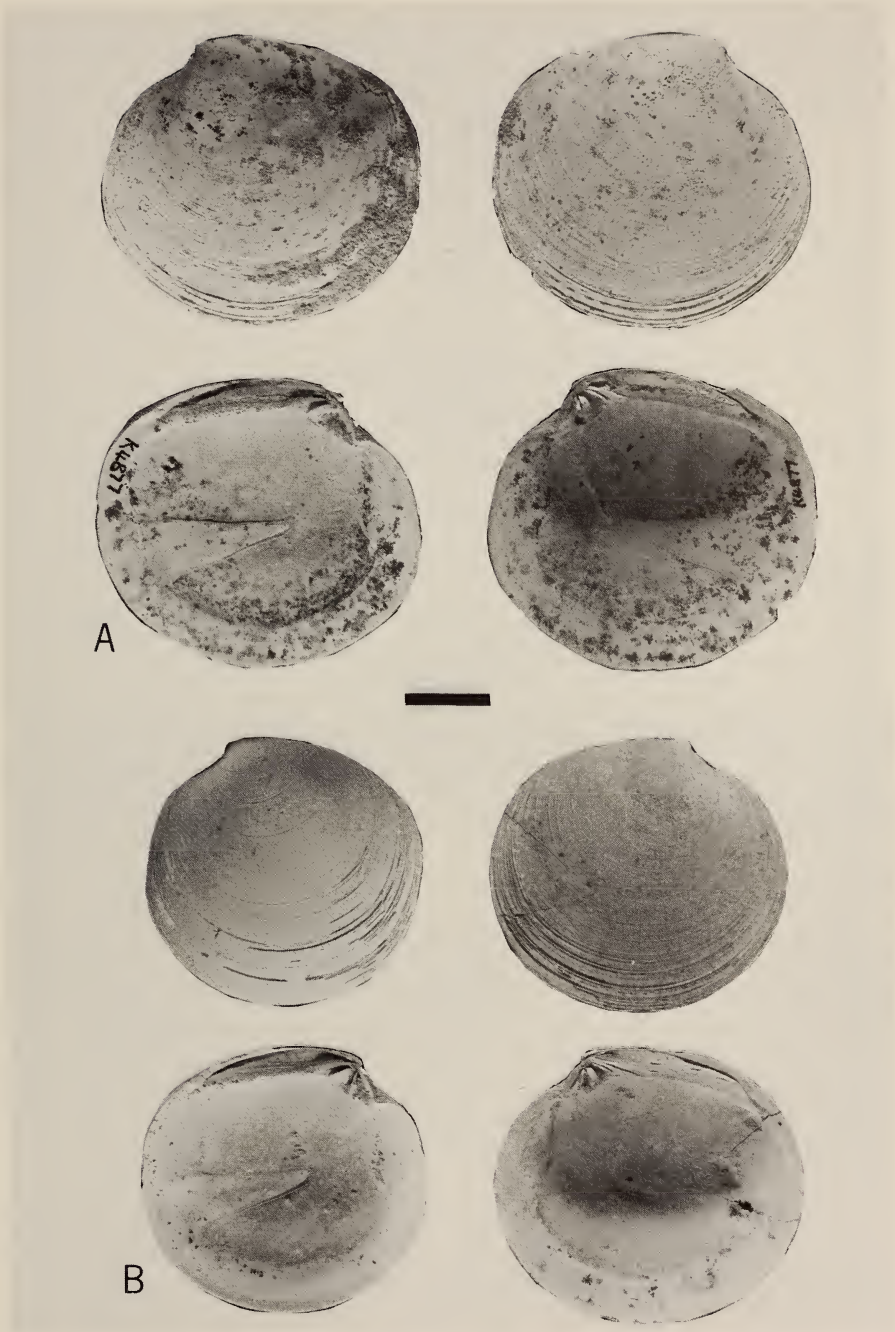


Fig. 39. *Dosinia sicarisinus*. A. Holotype, external and internal view of both valves. B. Paratype. Scale = 20 mm.



Fig. 40. *Dosinia sicarisinus*. Hinge details of right (upper) and left (lower) valves.

Zone 12, 50 m Complex. SAM-PQ-HB569, both valves (hinge of right valve missing), 62,8 × 68,0 mm, Hondeklip Zone 4A, 50 m Complex. USNM 400993, both valves, 63,6 × 62,5 mm, 2 left valves, 66,3 × 64,5 mm, 61,8 × 63,2 mm, Hondeklip, 50 m Complex.

Description

Shell proportions somewhat variable, generally longer than wide but occasionally wider than long. Sculpture of concentric lines, barely lamellose anteriorly and posteriorly. Lunule well defined; escutcheon lacking. Pallial sinus horizontal to slightly ascending, apically narrowed. Left and right hinges with small anterior lateral tooth set at angle to anterior cardinal tooth; posterior cardinal tooth in right valve bifid; anterior cardinal tooth in left valve much less markedly bifid, with very narrow longitudinal slit.

Remarks

The present material bears little resemblance to the extant species of *Dosinia* from southern Africa. Apart from attaining a much larger size than any of the living species, *D. sicarisinus* also differs in the very distinctive narrowly triangular pallial sinus that reaches to below the umbo. *Dosinia exoleta* (Linnaeus) of the Mediterranean, and also known from Norway to North Africa, has a broader pallial sinus, and possesses lamellar concentric rings.

In general appearance and size, the present material resembles some of the Tertiary species from New Zealand, especially *D. (Raina) bartrami* Laws, 1930. This latter, however, has a shallow pallial sinus, and the shallow lunule of the subgenus (see Keen 1969: N679). *Dosinia sicarisinus* is placed in the subgenus *Dosinia* for lacking an escutcheon and lamellose concentric rings.

Etymology

The specific name is derived from the Latin 'sicarius', a murderer, and 'sinus', a bay, and alludes to Moordenaarsbaai, a coastal embayment close to the Hondeklip type localities.

Family **Pholadidae**

Barnea truncata (Say, 1822)

Barnea truncata: Nicklés, 1950: 232, fig. 454. Barnard, 1964: 565. Kilburn & Rippey, 1982: 203. Kensley, 1985a: 116.

Material

SAM-PQ-KN356, 2 specimens, left and right valves, approx. 60 mm and 75 mm in length; right valve, approx. 50 mm in length, Koingnaas KN-1. SAM-PQ-HB26, 3 worn hinges, Hondeklip, 30 m Complex.

Previous records

Living: Senegal to Angola; east coast of U.S.A.; numerous fresh dead shells from Table Bay in South African Museum collection.

Fossil: Milnerton, Table Bay (Late Pleistocene); borehole in Kuiseb River, South West Africa-Namibia, 9 miles (14,5 km) from sea (Geological Survey, determined by K. H. Barnard).

Class SCAPHOPODA

Family **Dentaliidae**

Dentalium sp.

Fig. 41

Material

SAM-PQ-KN570, fragments, Koingnaas KN-1. SAM-PQ-KN376, several fragments, Koingnaas KN-1.

Description

Shell gently convex; with 16 rounded ribs at narrower end (1,8 mm diameter); ribs equal in width to concave furrows between them; at about 3,0 mm diameter, much narrower intermediate rounded ribs (1 between 2 larger ribs) becoming apparent; 26 ribs present.



Fig. 41. *Dentalium* sp. Fragments. Scale = 5 mm.

Remarks

The present material bears little resemblance to any living species of *Dentalium* described from southern Africa.

DISCUSSION

FAUNAL COMPOSITION

The following table is a broad-scale analysis of the faunal composition of the fossil molluscs from the Hondeklip area collected during this study. Material identified to generic level only is excluded (15 genera).

Total number of species	92	
Total number of extinct species	45	(49%)
Lyellian percentage (percentage extant)		51%
Total number of species still living on east and west coasts	27	
Total number of species living on east coast only	11	
Total number of species with West African-Mediterranean affinities	9	

Extinct species also present in east-coast deposits	4	
Total number of species from 50 m Complex	78	
Total number of extinct species from 50 m Complex	37	(47%)
Lyellian percentage		53%
50 m Complex species recorded by Carrington & Kensley (1969) but not found during course of this study	4	
(of which 3 are extinct)		
Total number of species from 30 m Complex	48	
Total number of extinct species from 30 m Complex	19	(40%)
Lyellian percentage		60%
Number of species common to 50 m and 30 m Complexes	34	
Number of extinct species in common	11	

From the previous summary, several topics require further comment. Notably, the 50 m Complex shows a higher diversity than the 30 m Complex (78 species as against 48). A glance at the species list (Table 1), which records the depositional environment of the beds from which the molluscs were obtained, shows that a greater range of environments was available in the 50 m Complex (viz. back-barrier, tidal-inlet, and distal lower-shoreface deposits, as against only near-shore open-coast deposits in the 30 m Complex). It is thus tempting to attribute the higher diversity of the 50 m Complex to the wider range of habitats. However, exclusion of specimens obtained only from 50 m Complex tidal-inlet and back-barrier deposits from the species list removes only nine species (two extinct), and the comparative diversity becomes 69 species (35 extinct) as against 48 species (19 extinct). This reflects the fact that the shelly beds in the 50 m Complex back-barrier-related facies are transported assemblages consisting of a mixture of calm-water and open-coast forms. Additionally, calm-water species may also inhabit the substrate below average wave-base, and become incorporated into open-coast facies, provided the open-coast temperature regime is within species tolerances.

As shown for the Late Pleistocene at Verlorevelei (Tankard 1975), thermally anomalous back-barrier environments increase species-diversity by the addition of warm-water taxa to the faunal composition. A modern example of such localized habitats is Sandvis Lagoon (Sandwich Harbour) near Walvis Bay (Kensley & Penrith 1977). However, in such cases the contrast between the back-barrier and open-coast assemblages is clear-cut. This is evidently not the case with the Hondeklip fauna, but this observation is qualified by the absence of large life assemblages preserved in the 50 m Complex back-barrier facies.

In the 50 m Complex back-barrier facies, only *Dosinia sicarisinus*, *Donax haughtoni*, *Phaxas decipiens*, *Standella namaquensis*, and *Tivela* cf. *compressa* have been found in life positions. In open-coast facies, *Lutraria* sp. has been found in life position around the lower-shoreface-upper-shoreface facies boundary in the 50 m Complex; in the 30 m Complex, *Donax rogersi* and *Standella*

namaquensis occur in life positions in the upper shoreface. *Striostrea margariticea* has been found attached to rocks in open-coast contexts in both complexes.

In Table 1 the species obtained from deposits on the properties of Koingnaas and Swartlintjiesrivier have been indicated separately owing to the unique additions to the faunal list those beds have contributed. In the case of Koingnaas (KN) and Swartlintjiesrivier (SL) samples, this is further warranted since the beds are distal lower-shoreface deposits of the 50 m Complex. The curious mix of intertidal and deeper-dwelling forms (e.g. *Dentalium*, *Ringicula*, *Tugali*, and *Turritella declivis*) in these samples, together with the muddy nature of the enclosing sediment, is consistent with a depositional environment transitional to offshore conditions. As such, the KN sample has contributed most to environmentally-based diversity in the 50 m Complex.

Removing species unique to these samples (KN, SL, and KL) from the faunal list results in a 50 m–30 m Complex diversity contrast of 64 species (30 extinct) as against 39 species (14 extinct), respectively. Excluding these examples, as well as species from the 50 m Complex tidal-inlet and back-barrier facies from the faunal list, results in a diversity contrast of 54 species (28 extinct) as against 39 species (124 extinct) for the 50 m and 30 m Complexes, respectively. Only by not excluding the KL sample from the latter calculation is the diversity contrast narrowed: 54 species (50 m Complex) as against 48 (30 m Complex). Thus the higher diversity of the 50 m Complex is either real, or an



Fig. 42. Mactrid hinge remains from Koingnaas KL south face. Scale = 30 mm.

unavoidable bias due to the nature of the available exposures. In addition, any reworked forms possibly present in the 30 m Complex will reduce the diversity contrast.

TABLE 1

Species of Mollusca obtained from four properties in the Hondeklip area of the Namaqualand coast, reflecting the complex and depositional facies from which they were obtained.

Habitat: R = Rocky, S = Sandy, RiS = Rock in sand, M = Muddy. W/E: Species confined to either west (W) or east (E) coasts. TIL = Tidal-inlet facies. BBR = Back-barrier facies. USH = Upper-shoreface facies. LSH = Lower-shoreface facies. DLS = Distal lower-shoreface facies. KN = Koingnaas KN. KL = Koingnaas KL. SL = Swartlintjies SL. † = Extinct.

Species	Habitat	W/E	50 m Complex					30 m Complex		
			TIL	BBR	USH	LSH	DLS (KN/SL)	USH	LSH	LSH (KL)
GASTROPODA										
<i>Afrocominella capensis</i> (Dunker in Philippi, 1844)	R		+	+	+					
<i>Amblychilepas scutellum</i> (Gmelin, 1791)	R		+	+	+			+		
† <i>Argobuccinum casus</i> sp. nov.				+	+		+			
† <i>Bolma anoropha</i> sp. nov.							+			
<i>Bullia annulata</i> (Lamarck, 1816) . .	S			+	+					
<i>Bullia digitalis</i> (Dillwyn, 1817) . .	S		+	+	+			+		+
<i>Bullia laevissima</i> (Gmelin, 1791)	S/M		+							
† <i>Burnupena aestus</i> sp. nov.				+	+					
<i>Burnupena papyracea</i> (Bruguère, 1789)	R		+	+	+					
† <i>Burnupena rogersi</i> sp. nov.			+							
† <i>Calliostoma depressa</i> Carrington & Kensley, 1969				+						
<i>Cantharidus (Jujubinus) striatus</i> . . (Linnaeus, 1758)		W		+						
<i>Calyptraea helicoidea</i> Sowerby, 1883	R	E								+
† <i>Calyptraea kilburni</i> nom. nov.	?R		+	+	+		+	+	+	+
† <i>Calyptraea viridarena</i> Carrington & Kensley, 1969	?R			+	+					
† <i>Clanculus lutosus</i> sp. nov.							+			
† <i>Clanculus murrayi</i> Carrington & Kensley, 1969			+	+	+				+	
<i>Conus mozambicus</i> Hwass in Bruguère, 1789	R		+	+	+			+		
<i>Crepidula porcellana</i> Lamarck, 1801	R	W		+			+			
† <i>Crepidula deprima</i> sp. nov.	R		+	+	+					
<i>Cylichna tubulosa</i> Gould, 1859 . .		E					+			
<i>Diodora elevata</i> (Dunker, 1846) . .	R			+	+	+	+	+	+	+
† <i>Drillia tempestae</i> sp. nov.			+	+	+					
† <i>Epitonium lycocephalum</i> sp. nov.				+					+	

Species	Habitat	W/E	50 m Complex					30 m Complex		
			TIL	BBR	USH	LSH	DLS (KN/SL)	USH	LSH	LSH (KL)
GASTROPODA (<i>contd</i>)										
† <i>Fasciolaria dinglei</i> sp. nov.					+					
† <i>Fissurella glarea</i>	?R							+	+	
Carrington & Kensley, 1969										
† <i>Fissurella robusta</i>	R		+	+	+	+				
Sowerby, 1892										
<i>Fissurellidea aperta</i>	R						+			
(Sowerby, 1825)										
<i>Fusus faurei</i>			?	?	?	?	?			
Barnard, 1959 (Koingnaas)										
<i>Gibbula zonata patula</i> ssp. nov. . .	R		+	+						
† <i>Haliotis saldanhae</i>	R				+		+			
Kensley, 1972										
<i>Helcion</i> sp.	R		+							
† <i>Hesperato oppenheimeri</i>			?	?	?	?	?			+
Carrington & Kensley, 1969										
<i>Littorina</i> sp.	R								+	+
<i>Marginella</i> sp.			+	+						+
<i>Melanella</i> sp.			+							
† <i>Melapium hawthornei</i> sp. nov. . . .							+			+
† <i>Namamurex odontostoma</i>			+	+	+					
Carrington & Kensley, 1969										
<i>Nassarius kochianus</i>		E								+
(Dunker, 1846)										
† <i>Nassarius litorafontis</i>			?	?	?	?	?			+
Carrington & Kensley, 1969										
<i>Natica</i> cf. <i>adansoni</i>	S/M	W								+
Blainville, 1824										
<i>Nucella dubia</i> (Krauss, 1848)	R		+						+	
† <i>Nucella praecingulata</i>			+	+	+	+	+	+		+
(Haughton, 1932)										
† <i>Ocenebra bonaccorsii</i>			+							+
Carrington & Kensley, 1969										
<i>Ocenebra purpuroides</i>	R		+							
(Reeve, 1845)										
† <i>Ocenebra petrocyon</i> sp. nov.										+
<i>Oxystele sinensis</i> (Gmelin, 1791)	R	E	+	+	+	+	+	+		
<i>Patella argenvillei</i> Krauss, 1848	R		+	+	+				+	
<i>Patella barbara</i> Linnaeus, 1758 . . .	R		+	+	+				+	
<i>Patella granatina</i> Linnaeus, 1758 . .	R								+	
† <i>Patella hendeyi</i> sp. nov.	R			+	+					
† <i>Patella hoffmani</i> sp. nov.	R		+	+	+	+				
<i>Patella miniata</i> Born, 1778	R								+	+
<i>Patella</i> sp.									+	+
† <i>Pseudoliva lutulenta</i> sp. nov.							+			
<i>Ringicula turtoni</i> Bartsch, 1915 . . .		E					+			

Species	Habitat	W/E	50 m Complex					30 m Complex		
			TIL	BBR	USH	LSH	DLS (KN/SL)	USH	LSH	LSH (KL)
GASTROPODA (contd)										
<i>Sinum concavum</i> (Lamarck, 1822)		W								+
† <i>Terebra canisaxi</i> sp. nov.				+	+			+		
† <i>Thais arenae</i> sp. nov.										+
<i>Tricolia capensis</i> (Dunker, 1846)	R		+	+						
† <i>Triumphis dilemma</i> Kilburn & Tankard, 1975			+	+	+					
† <i>Trophon carringtoni</i> sp. nov.						+				
<i>Tugali barnardi</i> (Tomlin, 1932) ...		E							+	
<i>Turbo cidaris</i> Gmelin, 1791	R		+	+	+	+	+	+	+	+
<i>Turritella carinifera</i> Lamarck, 1822	S			+	+			+	+	+
<i>Turritella declivis</i> Adams & Reeve, 1848		E						+		
† <i>Turris nigrovitta</i> Carrington & Kensley, 1969 (Koingnaas)			?	?	?	?	?			
<i>Vermetus</i> sp.			+	+				+	+	
BIVALVIA										
<i>Arca avellana</i> Lamarck, 1819	?R	E						+		
† <i>Arca halmyrus</i> Carrington & Kensley, 1969 (Strandfontein)	?R		?	?	?	?	?			
<i>Arca noae</i> Linnaeus, 1758	?R	W								+
<i>Aulacomya ater</i> (Molina, 1782) ...	R		+	+						+
<i>Barnea truncata</i> (Say, 1822)	R	W						+		+
† <i>Cardita unica</i> sp. nov.										+
† <i>Carditella calipsamma</i> Carrington & Kensley, 1969			+	+	+	+	+	+	+	
<i>Cardium</i> sp.								+		
† <i>Chamelea krigei</i> Haughton, 1926	S		+	+	+	+				
<i>Chlamys</i> sp.							+			
<i>Choromytilus meridionalis</i> (Krauss, 1848)	R							+		
† <i>Corbula palaegialus</i> (Carrington & Kensley, 1969) (Strandfontein)			?	?	?	?	?			
† <i>Cuna aquaedulcensis</i> Kensley, 1977										+
† <i>Donax haughtoni</i> Carrington & Kensley, 1969	S		+	+	+	+				
† <i>Donax rogersi</i> Haughton, 1926 ...	S							+	+	
† <i>Dosinia sicarisinus</i> sp. nov.	S/M			+				+		
† <i>Gastrana fibrosa</i> Kilburn & Tankard, 1975	S				+					

Species	Habitat	W/E	50 m Complex					30 m Complex		
			TIL	BBR	USH	LSH	DLS (KN/SL)	USH	LSH	LSH (KL)
BIVALVIA (contd)										
† <i>Gastrana rostrata</i>	S						+			
Carrington & Kensley, 1969										
<i>Gastrana</i> sp.	S			+					+	
† <i>Glycymeris fulleri</i> sp. nov.	S							+		
? <i>Hiatella</i> sp.	R		+	+						
<i>Hinnites</i> sp.							+			
† <i>Isognomon gariesensis</i> sp. nov.							+	+		+
<i>Leporimetis hanleyi</i>	S/M	W					+	+		
(Dunker, 1853)										
<i>Lutraria</i> sp.	S/M			+	+	+	+	+	+	
† <i>Mactra</i> cf. <i>dernebergi</i>	S/M									+
Böhm & Weisfermel, 1913										
<i>Melliteryx capensis</i>	RiS	E						+		
(Sowerby, 1889)										
† <i>Notocallista schwarzi</i>	S							+		
(Newton, 1913)										
<i>Nuculana bicuspidata</i>	S/M	W						+		+
(Gould, 1845)										
† <i>Ostrea</i> cf. <i>subradiosa</i>	R						+			
(Böhm & Weisfermel, 1913)										
<i>Perna perna</i> (Linnaeus, 1758)	R		+		+				+	
† <i>Petricola prava</i>	R			+						+
Kilburn & Tankard, 1975										
<i>Phaxas decipiens</i> (Smith, 1904)	S/M		+	+						+
<i>Scissodesma spengleri</i>	S			+						
(Linnaeus, 1767)										
† <i>Standella namaquensis</i>	S		+	+	+				+	
Carrington & Kensley, 1969										
<i>Striostrea margaritacea</i>	R	E	+	+	+	+	+	+	+	+
(Lamarck, 1819)										
<i>Tellina ponsonbyi</i>	S/M	E				+			+	
(Sowerby, 1889)										
<i>Tellina trilatera</i> Gmelin, 1791	S		+	+					+	+
<i>Theora</i> sp.	S						+			
<i>Tivela</i> cf. <i>compressa</i>	S			+	+				+	
(Sowerby, 1851)										
<i>Venus verrucosa</i> Linnaeus, 1758	S	W		+	+				+	+
SCAPHOPODA										
<i>Dentalium</i> sp.	S/M						+			
POLYPLACOPHORA										
<i>Chaetopleura pertusa</i>	R		+							
(Reeve, 1847)										
cf. <i>Chiton</i> sp.	R		+	+	+		+			+
cf. <i>Dinoplax</i> sp.	R		+							

Table 1 indicates the preferred habitats of most species. In a number of cases there is uncertainty about habitat, especially for extinct species. While most are open-coast forms, there are calm-water components present (e.g. *Bullia laevis*, *Phaxas decipiens*, *Dosinia sicarisinus*, *Lutraria* sp., *Leporimetis hanleyi*). Among the open-coast forms, rocky-shore species outnumber sand and mud inhabitants almost two to one. Among the rocky-shore forms are a number of grazers and algal inhabitants such as *Haliotis*, *Crepidula*, *Oxysteles*, *Turbo*, *Calliostoma*, and *Patella*. Predators such as *Argobuccinum*, *Namamurex*, *Thais*, *Ocenebra*, *Conus*, and *Terebra* are also abundant. Filter feeders such as *Turritella*, scavengers like *Bullia* and *Nassarius*, and parasitic forms such as *Epitonium* and *Melanella* are also present, indicating a rich and diverse environment with numerous habitats. Of the sand and mud dwellers there are suspension and filter feeders (*Donax*, *Dosinia*, *Scissodesma*, *Venus*, *Lutraria*), as well as deposit feeders (*Tellina*).

Of the species recorded by Carrington & Kensley (1969), only four have not been found during the present study. These are *Fusus faurei*, *Turris nigrovitta*, *Corbula palaegialis*, and *Arca halmyrus*, all recorded from the 50 m Complex. *Nassarius litorafontis* and *Hespererato oppenheimeri*, recorded from the 50 m Complex by Carrington & Kensley (1969), have been found in the 30 m Complex in this study.

ZOOGEOGRAPHIC AFFINITIES

There is a small west African–Mediterranean component of nine species in the faunal list: *Arca noae*, *Barnea truncata*, *Cantharidus (Jujubinus) striatus*, *Crepidula porcellana*, *Leporimetis hanleyi*, *Nuculana bicuspidata*, *Natica* cf. *adansoni*, *Sinum concavum*, *Venus verrucosa*. Of these, *Arca noae*, *Cantharidus (Jujubinus) striatus* and *Natica* cf. *adansoni* are strictly West Africa–Mediterranean in distribution; the present fossil records are the most southerly for all three. *Nuculana bicuspidata* occurs live in West Africa, and is known as a Pleistocene fossil from Velddrif (Kruispad), Table Bay (Milnerton), and Port Elizabeth (Redhouse) (See Kilburn & Tankard 1975: 206). *Leporimetis hanleyi* is known live from Luanda, while an isolated population occurs at Sandvis, just south of Walvis Bay. It is recorded as fossil in the Late Pleistocene in the Saldanha area, and also at Redhouse, Knysna, Sedgfield, and Klein Brak River. *Venus verrucosa* and *Crepidula porcellana* both occur from North Africa, around the Cape, to Natal. *Barnea truncata* is known from the Late Pleistocene of Table Bay (Kensley 1985a) and also from fresh dead shells washed ashore at the same locality. *Sinum concavum* is an extant West African species, known from Senegal to Angola (Nicklés 1950). This so-called West African component thus represents a mix of widespread temperature-tolerant species, as well as less temperature-tolerant forms now restricted to more tropical areas.

The present-day distribution of living species represented in the faunal list shows a majority of forms (27 species, 29%) occurring on both east and west coasts of southern Africa. Only 11 species are at present restricted to the east

coast: *Calyptraea helicoidea*, *Melliteryx capensis*, *Nassarius kochianus*, *Oxystele sinensis*, *Ringicula turtoni*, *Arca avellana*, *Striostrea margaritacea*, *Tellina ponsonbyi*, *Tugali barnardi*, *Turritella declivis*, *Cylichna tubulosa*. Of these, only the Indo-Pacific *Arca avellana* has a distribution extending north of southern Mozambique.

The inferring of past sea-temperature regimes based on the known temperature ranges of living species is a complex issue fraught with pitfalls. Some guidelines do exist. Tankard (1975b: 33) presented temperature minima for a range of Pleistocene molluscs of South Africa, and indicated a warm-water affinity for a number of west-coast fossils. Several of these occur in the present suite:

	Temperature minima
<i>Nuculana bicuspidata</i>	17°C
<i>Scissodesma spengleri</i>	14°C
<i>Tellina ponsonbyi</i>	14°C
<i>Leporimetis hanleyi</i>	17°C

Kilburn & Rippey (1982) mention that *Striostrea margaritacea* spawns when monthly average temperatures exceed 20°C.

Examining the nine 'West African', and the 11 east-coast forms (with their implied warmer-water requirements), it is seen that 7 species, including *Striostrea margaritacea* and *Nuculana bicuspidata*, occur in both the 50 m and 30 m Complexes. Fourteen of the 20 species occur in the 50 m Complex, 12 in the 30 m Complex. It is thus inadvisable to attribute a colder temperature regime to the 30 m Complex and a warmer regime to the 50 m Complex. Nevertheless, there is undeniably a component showing a warm-water bias in the present suite of fossils, deduced from known temperature ranges of living species. The temperature requirements for the extinct forms, with the greater preponderance of species in the 50 m Complex, can only be guessed at. The reasons for the extinction of these forms are probably related in part to sea-temperature changes.

An oculinid coral, found encrusting rocks at Hondeklip in 50 m Complex exposures, and tentatively identified as *Schizoculina fissipara* (Milne Edwards & Haime), casts further light on the question of temperature regimes. According to Laborel (1974), modern *S. fissipara* is adapted to low-salinity, warm, Guinean waters, and has a ramose morphology. However, encrusting to subramose forms (as in the present case) occur at the extremes of its range where periodic upwelling takes place. This instance probably represents the most southerly occurrence of *S. fissipara* in the fossil record and implies the extension of tropical water southward to Hondeklip latitudes. Lithological evidence of upwelling off Hondeklip during 50 m Complex times comes from phosphorite rinds interbedded with regressive storm gravels deposited in the bedrock-defined embayment during the earlier stages of bedrock emergence, prior to the establishment of back-barrier conditions. The thin phosphorite rinds mark intervening

fairweather periods during the deposition of the storm gravel. Hondeklip was probably situated adjacent to a marine regime characterized by the interaction of upwelling and south-flowing tropical currents during the period of deposition of the 50 m Complex.

The warm-water species common to both the 50 m and the 30 m Complexes, especially the abundant *Striostrea margaritacea*, undoubtedly point to a sea-temperature regime considerably higher than that prevailing on the west coast at present. Over the period of deposition of both complexes, however, a cooling trend must be inferred from the presence of numerous species living at present on the west coast. The apparent reduction in diversity reflected by the 30 m Complex may be indicative of cooling. Significantly, *Choromytilus meridionalis* evidently first appears during 30 m Complex times (Early Pleistocene). The cooling trend is also indicated by the extinction of *Striostrea margaritacea* on the west coast subsequent to the Early Pleistocene.

The Hondeklip fossil fauna probably represents a mixture of forms at different points in their history, reflecting both the influence of the cold Benguela system and subtropical waters, fluctuating, glacially controlled sea-levels and temperatures, along with varying temperature requirements. Thus, some specimens may represent the last members of a population that was dying out owing to decreasing temperatures, others a population adapting to fluctuating conditions, others an 'experimental' pioneering stock having tenuous reproductive success, and still other temperature-tolerant and actively reproducing populations.

FAUNAL COMPARISONS

Evaluation of the fauna from Hondeklip and vicinity must necessarily take the following into consideration.

The faunal list is undoubtedly incomplete. An unavoidable bias is, of course, the very nature of the geological record. Only deposits accumulated during regression from the sea-level maxima are available for examination; deposits closer to the regressive maxima are not available, nor are deposits of the transgressions. Thus the sedimentary packages available for sampling were deposited during the earlier stages of recovery from major polar deglaciations. In this sense successive complexes are somewhat directly comparable, but this may also make for the reduction of faunal dissimilarity between complexes. Original community patchiness, differential transport, preservational bias due to dissolution, and sampling bias (e.g. the tendency for small forms to be overlooked) all contribute to an incomplete faunal list.

The latitudinal ranges of species in deposits equivalent to the 50 m and 30 m Complexes are largely unknown or uncertain. Sampling was restricted to a few localities in close proximity.

The temporal ranges of species are similarly unknown or uncertain. The Late Tertiary and Middle Pleistocene are practically unsampled. The best comparative faunal lists exist for the Late Pleistocene (e.g. Tankard 1975a; Kensley 1985a).

In spite of these limitations, comparisons with other west-coast assemblages are instructive.

Bogenfels Tertiary Deposits

While the overall fauna of the Tertiary deposits of Bogenfels, South West Africa–Namibia, is distinctive and very different from any present-day assemblage (Böhm & Weisfermel 1913; Böhm 1926) there are a few elements that hint at a distant relationship with the Hondeklip suite.

The presence of a species of *Pseudoliva* (with one living species in West Africa, and two extinct species from Bogenfels), mactrid hinges closely resembling *Mactra* (*Barymactra*) *dernburgi* Böhm & Weisfermel from Bogenfels (Fig. 42), and a single oyster valve almost identical with *Ostrea subradiosa* Böhm (Fig. 35) suggest that there may well be Tertiary stragglers or their descendants in the Hondeklip assemblage. This suggestion, however, must be treated as highly speculative.

Marine Neogene of Ysterplaat

Tankard (1975a) provided a list of 13 molluscs recovered from the Miocene of Ysterplaat, Cape. Olson (1985), on the basis of fossil penguin material from the same locality, placed the assemblage in the Early Pliocene. The bivalves *Cardium edgari* Newton, 1913, and *Glycymeris borgesii* (Cox, 1939) support a Neogene age. Also taken from the Ysterplaat site were *Donax serra* Dillwyn, 1817, *Scissodesma spengleri*, *Dosinia lupinus* and a *Pitar*, since identified as *Notocallista schwarzi*. Of these all but *Donax serra* and *Dosinia lupinus* occur at Hondeklip. While most of the Ysterplaat *Dosinia* specimens are within the usual size range of *D. lupinus*, a few reach the size of *D. sicarisinus* described above. Unfortunately, the Ysterplaat material is all mouldic, and a clear impression of hinge and mantle details is lacking, making a positive identification difficult. *Donax serra* is discussed in the next section.

Early Pliocene molluscs from Langebaanweg, Cape

Kensley (1972, 1977) recorded a number of molluscs from Langebaanweg, several of which also occur at Hondeklip. These are *Cuna aquaedulcensis*, *Bullia digitalis*, *B. laevisima*, *Tricolia capensis*, *Haliotis saldanhae*, and *Thais dubia*. *Cuna aquaedulcensis* is locally abundant in the 30 m Complex at Hondeklip. *Bullia digitalis* is abundant in both the 30 m and 50 m Complexes; its living range from South West Africa–Namibia to Transkei would indicate that this is a temperature-tolerant species, and its presence in deposits from the Pliocene to the Holocene is not surprising.

The fossil distribution of *Donax serra*, however, is difficult to explain. It has been recorded from the Pliocene of Ysterplaat (Tankard 1975a), and Langebaanweg (Kensley 1972, 1977), and the Pleistocene of Lüderitz, Orange River mouth, Velddrif, Sedgfield (Barnard 1962), and Table Bay (Kensley 1985a). It has not been seen in the Hondeklip deposits under discussion, where *D. rogersi* (30 m

Complex) and *D. haughtoni* (50 m Complex) are both abundant. Its present-day distribution is from South West Africa–Namibia to Transkei, while De Villiers (1975) reported the species to reproduce in a temperature range of 13–17°C. Inappropriate temperature thus seems unlikely to be the reason for its absence from the Hondeklip area. It is possible that local competition from the two extinct species during the Early Pleistocene precluded the establishment of a population of *D. serra* in the Hondeklip area.

Verlorevlei–Saldanha Pleistocene deposits

A number of species recorded from the Pleistocene of the south-western Cape around Verlorevlei and Saldanha (Kilburn & Tankard 1975) are present in the Hondeklip assemblage. The extinct species *Petricola prava*, *Nucella prae-cingulata*, *Triumphis dilemma* and *Fissurella robusta* were obtained from deposits at 10 masl at Saldanha Bay. The latter two species occur in the 50 m Complex and the former two in both the 50 m and the 30 m Complexes at Hondeklip. *Cerithidea bifurcata* Kilburn & Tankard, 1975, an extinct species also obtained from the 10 masl deposit, has not yet been found in Namaqualand.

Tankard (1975c) correlated the Saldanha deposit at 10 masl with the 50 m Complex in Namaqualand on the basis of the four species mentioned above. The presence of *Fissurella robusta* and *Triumphis dilemma* suggests that this correlation may be correct but it should be verified by additional criteria. Accepting the equivalence of the deposits, comparison of the faunal lists shows an additional 13 extant species in common with the 50 m Complex at Hondeklip, all of which occur on both west and east coasts. Of the Saldanha fauna, only *Patella tabularis* Krauss, 1848, *P. concolor* Krauss, 1848, and *Peristernia nassatula* (Lamarck) are south- and east-coast species not present off Saldanha today. Tankard (1975c) attributed the absence of *Striostrea margaritacea* and *Donax haughtoni* from the Saldanha deposit to colder water conditions there during the 50 m Complex times.

Gastrana fibrosa, a probably extinct species recorded from the Late Pleistocene in the south-western Cape, extends back into the Late Pliocene in central Namaqualand, as shown by its occurrence in the 50 m Complex. The extinct Late Pleistocene species *Crepidula capensis praerugulosa* Kilburn & Tankard, 1975, is not present in the Hondeklip assemblage, though *Crepidula porcellana* is.

CONCLUDING REMARKS

Significantly, the warm–cold distinction between the 50 m and 30 m Complexes respectively (or across the Plio–Pleistocene boundary), is not clear-cut on the basis of existing data, due to the considerable faunal similarity between the complexes. Notably, there are 34 species (11 extinct) common to both complexes. Of the species unique to the 30 m Complex, only five are relatively abundant, viz. *Donax rogersi*, *Fissurella glarea*, *Choromytilus meridionalis*, *Cuna*

aquaedulcensis, *Ocenebra petrocyon*. The reduction of diversity and the appearance of *Choromytilus meridionalis* may suggest a cooler regime during 30 m Complex times, relative to the 50 m Complex.

The value of *Donax haughtoni* and *Donax rogersi* as zone fossils for the 50 m and 30 m Complexes, respectively, is verified in this study. *Donax haughtoni* is present at least as far south as the Olifants River. *Donax rogersi*, the 30 m Complex zone fossil, is present at least as far south as Doringbaai and has been found as far north as Walvis Bay (pers. obs.). However, there are no faunal lists from 30 m Complex correlates in the south-western Cape for comparison. It appears that only subsequent to the Early Pleistocene did the Namaqualand west-coast mollusc fauna more closely resemble the modern fauna. This probably reflects the increasing dominance of the Benguela system and restriction of warmer waters to the north, the cooler regime facilitating a species radiation northwards from the south-western Cape. The ecological niche of *Striostrea margaritacea* was usurped, to some extent, by the mytilids and patellids, the latter to become an important food resource of early man on the west coast. The first appearance of *Patella compressa*, the kelp limpet, already present by the Late Pleistocene, is an important datum yet to be established.

Sedimentological aspects of the complexes suggest that, in the Hondeklip area during 50 m Complex times, the coast was characterized by a sea-level interaction with the bedrock topography that resulted in an embayed coast concomitant with conditions for the development of extensive back-barrier environments. In contrast, the 30 m Complex is characterized by relative insulation from antecedent topographic effects, resulting in a more exposed coastal regime. Superimposed upon these littoral influences are the effects of the adjacent oceanographic temperature regime. Thus a secure database from which to deduce Late Cenozoic palaeoclimatic influences will only exist once the regressive packages are examined sedimentologically and faunistically sampled on a regional basis in order to resolve the large-scale changes in the boundaries of marine zoogeographic provinces in time, to recognize the environmental vectors such as depositional palaeodepth and possibly thermally anomalous lagoons, and allied to the latter, to evaluate the roles of antecedent topography and sediment supply.

In conclusion, this study suggests that molluscs have potential for a significant contribution in the unravelling of Late Cenozoic history. More extinct molluscs were found than expected and the relatively high level of endemism holds promise that more zone fossils may emerge. The extant component of the fauna permits some extrapolations of temperature tolerances and environmental preferences. An overall cooling trend is reflected in the approach of successively younger assemblages towards the modern west-coast faunal composition.

Comparison of Palaeogene, Neogene, Quaternary, and extant faunas suggests that extinction, speciation, and migratory colonizations were staggered as a reflection of differing temperature tolerances, habitat creation-destruction, and competition. However, a regional mollusc-assemblage zonation scheme must

in time necessarily be supplemented by zonations of ostracode and benthic foraminiferal assemblages. Planktonic Foraminifera are evidently very scarce in these littoral deposits, while nannoplankton has not yet been collected, but efforts to recover these microfossils may aid correlation with deep-sea data and the global record. Resolution of the tectonic component of the coastal-plain marine record awaits reliable regional correlations.

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